FINAL

Alternatives Formulation Report

Rio Grande Canalization Project

PREPARED FOR: **International Boundary and Water Commission, United States Section**

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Austin, Texas

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ACRONYMS AND ABBREVIATIONS

BLM	Bureau of Land Management
BMP	Best management practices
cfs	cubic feet per second
cm	centimeter
EBID	Elephant Butte Irrigation District
EIS	Environmental Impact Statement
ft	feet
GRF	Gradient restoration facility
HEP	Habitat evaluation procedure
HSI	Habitat suitability index
HU	Habitat unit
km	kilometer
MOU	Memorandum of Understanding
NEPA	National Environmental Policy Act
NM	New Mexico
NMGF	New Mexico Game and Fish Department
NRCS	Natural Resource Conservation Service
O&M	Operation and maintenance
SCS	Soil Conservation Service
SWEC	Southwest Environmental Center
Parsons ES	Parsons Engineering Science, Inc.
the "Project"	Rio Grande Canalization Project
TPWD	Texas Parks & Wildlife Department
TX	Texas
U.S.	United States
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USIBWC	United States Section, International Boundary and Water Commission
WHAP	Wildlife habitat appraisal procedure

SECTION 1
EXECUTIVE SUMMARY

The United States Section of the International Boundary and Water Commission (USIBWC) is currently evaluating alternatives for modification of operation and maintenance (O&M) of the Rio Grande Canalization Project which extends from below Percha Dam in Sierra County, New Mexico to American Dam in El Paso, Texas. The alternatives address flood control measures and environmental actions that will constitute a major federal action. The National Environmental Policy Act (NEPA) of 1969 requires preparation of an Environmental Impact Statement (EIS) prior to implementation of a major project by a federal agency.

This alternatives formulation report represents the third milestone in the process of preparing an EIS. The first two milestones were publication of a Notice of Intent to prepare an EIS (published in August 1999) and scoping meetings for preparation of the EIS (completed in November 1999). Based on this report, selected alternatives for operation and maintenance will be evaluated in a draft EIS document for review by regulatory agencies and the general public. A final EIS will be subsequently prepared to address comments. The final EIS will be used as the basis for the Record of Decision, a document that defines the selected course of action and the need for mitigation measures.

Since the initial construction of the Canalization Project from 1938 to 1943, USIBWC has been responsible for maintaining its flood control and water delivery capabilities. To accomplish its mission, the agency performs operation and maintenance activities consisting of sediment removal from the channel and the lower end of arroyos; leveling of the floodway; vegetation management along channel banks, floodway, and levees; replacement of channel bank riprap; care of dams on arroyos; and maintenance of infrastructure such as levee roads, bridges, and gates at the American Dam.

The initial construction and subsequent operation and maintenance activities along the Project have altered the native riparian ecosystem that previously existed. The patterns of water flow from upstream reservoirs are controlled by USBR to meet the needs of downstream agricultural users. The flow regime in the river is significantly different from conditions prior to construction of reservoirs, although the Canalization Project did not affect the water release patterns. As a result of the Canalization Project and prior reservoir construction, the amount of aquatic and terrestrial habitat available to fish and wildlife is very limited within the Project boundaries. Alternatives have been formulated that include various environmental restoration and enhancement actions intended to improve the available habitat while achieving the USIBWC mission objectives of flood control and water delivery.

The alternatives formulation process began with identification of preliminary alternatives at a conceptual level. The preliminary alternatives were screened using functionality, feasibility, and potential for environmental enhancements as the criteria. The five alternatives retained for more detailed review were refined based on environmental criteria and analysis of potential enhancement sites. The alternatives were then evaluated on the basis of cost and non-cost factor, for selection of a preferred management alternative for the Project. The following list describes the formulation process:

1. Identify potential actions taking into account input by USIBWC and issues and concerns from regulatory agencies and the general public. Gather information on possible locations for environmental enhancements from previous reports, maps, aerial photographs, and site visits.
2. Prepare a preliminary matrix of alternatives identifying management strategies developed as combinations of proposed actions listed in Step 1, above.
3. Screen alternatives based on general objectives of functionality, feasibility, and potential for environmental enhancements.
4. Select environmental criteria for further evaluation of the alternatives. Habitat units (HU) were defined as a specific measure of environmental enhancement potential.
5. Identify and map locations for proposed actions under each alternative based on existing documentation and site-specific inspections. The Project area was subdivided into seven geographically-distinct reaches or management units (MUs).
6. Develop detailed descriptions of the alternatives based on the extent of environmental enhancement (habitat units) and spatial distribution of enhancement sites.
7. Evaluate the alternatives for compatibility with the Project's requirements for flood control using hydraulic modeling. Flood control features were added, or alternatives modified, as necessary to satisfy the objective of achieving flood control for a design 100-year storm event throughout the Project.
8. Select a preferred alternative. The selection was based on effects of the alternatives in terms of modified operation and maintenance, cost, required implementation effort, and performance of proposed enhancements.

The main features of the five alternatives developed using this process are given below.

Alternative 1, Maintain Current Operation. Current operation and maintenance practices are maintained in terms of:

- Sediment dredging and disposal;
- Vegetation control in the floodway and land leases; and
- Maintenance of no-mow zones and existing aquatic habitat structures.

Alternative 2: Modification of Operation and Maintenance. Includes Alternative 1 actions and the following:

- Implementation of erosion control at siphons;

- Additional aquatic habitat structures at current mitigation sites;
- Construct flood control levees; and
- Expand no-mow zones and minimize sediment dredging.

Alternative 3: Integrated USIBWC Land Management. Includes Alternatives 1 and 2 actions and the following:

- Additional aquatic habitat structures at new mitigation sites;
- Additional wetland, riparian, and terrestrial habitat at multiple sites;
- Modification of spoil disposal practices; and
- Discontinuation of most grazing leases.

Alternative 4: Targeted Stream Restoration. Includes Alternatives 1, 2, and 3 actions and the following:

- Acquisition of flood easements and property for levee setbacks;
- Tree planting outside right-of-way; and
- Re-creation of river meanders outside right-of-way.

Alternative 5: Multipurpose Watershed Management. Includes Alternatives 1, 2, 3 and 4 actions and the following:

- Sediment control in sub-basins;
- Backwater habitat at dams;
- Water quality improvement;
- Recreation areas; and
- Peak flows.

Sites for environmental actions were identified along the river based on their potential for aquatic, wetlands, riparian, and uplands habitat. The sites were evaluated by calculating the number of habitat units as a combination of each type of habitat. The following Table 1.1 lists the sites selected for the alternatives, their size, and their habitat unit scores. The site list is grouped by river management unit. The location is the distance in river miles north of American Dam.

Hydraulic modeling was performed to evaluate the impact of enhancements on the flood control performance of the project. The modeling confirmed the results of the 1996 USACE report that significant portions of the existing levee system were not tall enough to provide the design freeboard distance of three feet. Overtopping of the levees is predicted for the design 100-year storm with the current Project configuration.

Table 1.1 Enhancement Sites

Site Name	Location	Area (acres)	Habitat Units
Upper Rincon Valley River Management Unit			
Oxbow Restoration Site	104.5	24	22
Tipton Arroyo	104.0	35	27
Trujillo Arroyo	103.0	143	104
Montoya Arroyo	101.5	131	119
Holguin Arroyo	101.0	52	35
Green / Tierra Blanca	99.4	94	72
Sibley Arroyo Point Bar	98.0	93	62
Jaralosa Arroyo	96.4	1,276	744
Yeso Arroyo	93.5	157	130
Crow Canyon	92.0	1,428	600
Lower Rincon Valley River Management Unit			
Hatch Siphon	90.0	36	22
Wetlands Unit B	89.0	34	17
Wetlands Unit A	87.0	25	15
Garfield Drain	86.0	47	32
Placitas Arroyo	84.5	230	137
Remnant Bosque/Rincon	82.2	232	140
Angostura Arroyo	80.0	224	128
Rincon/Reed Arroyo	78.3	114	72
Bignell Arroyo	76.0	143	86
Seldon Canyon River Management Unit			
Dead Man's Curve	69.0	61	30
Broad Canyon	67.0	55	32
Leasburg Dam	62.0	6	5
Upper Mesilla Valley River Management Unit			
West Side	57.5	220	120
Levee Setback	56.5	68	45
Seldon Drain	55.5	16	11
Channel Cut	54.5	373	219
Wasteway No. 2A	52.5	36	15
Las Cruces River Management Unit			
Wasteway No. 5	50.0	36	21
Wasteway No. 39	48.5	47	25
Wasteway No. 8	47.5	33	26
Wasteway No. 39A	46.5	44	15
Lower Mesilla Valley River Management Unit			
Clark Lateral	42.5	76	36

Site Name	Location	Area (acres)	Habitat Units
NMGF Bosque (Picacho Bosque)	41.5	230	165
Mesilla Dam	39.5	16	10
Pole Planting Area	34.0	40	17
Wasteway No. 18	29.5	71	43
Del Rio Drain	26.5	70	42
Wasteway No. 19	25.5	39	21
Old Channel	25.0	95	53
Wasteway Nos. 31 and 20	22.0	17	12
El Paso River Management Unit			
Jimenez and Three Saints Lateral	19.5	82	52
East Drain	16.0	50	30
Wasteway No. 34	10.0	2	2
Wasteway No. 35	9.0	35	25
Nemexas Drain	7.0	51	34
Sunland Park	5.0	92	67
Cottonwood Grove	4.0	60	40
Anapra Bridge	3.0	98	47
Total		**6,645**	**3,821**

The alternatives were modeled by assuming a worst-case of completion of all enhancement and retention projects associated with Alternatives 3 and 4. The results indicated that water surface elevations would increase somewhat with the environmental actions. However, the flooding potential for those alternatives is about the same as the current situation with only about 7 percent of additional levees impacted by higher water elevations due to environmental actions. Based on water surface elevation and edge velocities, about 73 miles of levee improvements are required to protect against the 100-year flood.

Incremental costs for construction and operation and maintenance were estimated for each of the alternatives as compared with the current river management. The life cycle costs for a 30-year period for each alternative are given in the following table. Table 1.2 presents the incremental costs above the current operation and includes costs for flood control projects in Alternatives 2 through 5.

A scoring system was used to integrate results of the cost analysis, potential for creation of habitat, and protection from flooding. Alternative 3 had the highest score when considering the goals of environmental enhancement and restoration, flood control and water delivery, and feasibility of implementation. Based on this result, Alternative 3 was selected as the preferred alternative.

Table 1.2 Costs for Alternatives

(in millions of dollars)			
Alternative	**Annual O&M Cost (per yr)**	**Capital**	**Life Cycle Cost**
1. No Action	-	-	-
2. Modified Operation and Maintenance	3.1	65.0	112.4
3. USIBWC Integrated Land Management	6.1	122.0	213.8
4. Targeted River Restoration	8.4	172.6	300.2
5. Watershed Management	12.7	201.0	393.9

Due to the large scale and high cost of the preferred alternative, it is anticipated that implementation will occur over several decades. The first step will be a river management plan, which establishes a procedure for incorporating environmental actions into the overall operation of the Project.

It is envisioned that implementation would be governed using an adaptive management plan approach. The adaptive management plan would identify a governing committee of USIBWC and other state and federal agency personnel or work through coordination with the existing Citizens Forum or Watershed Council, or both, to plan and execute environmental actions within the Project. The committee would have responsibility for prioritizing sites and actions. The committee would also have responsibility for obtaining stakeholder input and obtaining funding from outside of USIBWC and the U.S. State Department. The USIBWC would retain decision-making authority based on input from the adaptive management committee.

SECTION 2
INTRODUCTION

2.1 Background

The USIBWC operates and maintains the Canalization Project (or Project), a 105.4-mile segment of the Rio Grande that extends from Percha Diversion Dam in New Mexico to American Diversion Dam in Texas. The Canalization Project, constructed from 1938 to 1943, entailed dredging of a main, deeper channel to facilitate water deliveries for irrigation, and placement of levees along two-thirds of its length for flood protection. Since completion of the Project, diversion dams in the channel and sediment/flood control dams in arroyos have been constructed.

Operation and maintenance activities consist of sediment removal from the normal flow channel and the lower end of arroyos; leveling of the floodway; vegetation management along channel banks, floodway, and levees; replacement of rock bank riprap; care of dams on arroyos; and maintenance of infrastructure such as levee roads, bridges, and gates at the American Dam.

USIBWC is currently evaluating alternatives for modification of operation and maintenance practices to enhance the environmental quality of the Canalization Project while preserving its functionality in terms of flood control and water deliveries. Proposed modifications constitute a major federal action, implementation of which requires preparation of an Environmental Impact Statement (EIS) as stipulated by the National Environmental Policy Act (NEPA) of 1969.

Figure 2.1 illustrates the NEPA process as it pertains to the Canalization Project. The initial three phases are publication of a Notice of Intent, scoping of the EIS, and formulation and selection of modified alternatives. Selected alternatives for operation and maintenance are then evaluated in a draft EIS document for review by regulatory agencies and the general public. A final EIS is subsequently prepared addressing comments received and used as the basis for the Record of Decision, a document that defines selected courses of action and need for mitigation measures.

This document describes the formulation and selection of management alternatives that will be evaluated in the EIS. The Notice of Intent for EIS preparation was issued by USIBWC on August 17, 1999. Scoping information was previously presented in a report prepared by Parsons Engineering Science, Inc. (Parsons ES) in November 1999. The Scoping Report summarized information gathered during two public meetings held October 5, 1999 in Las Cruces, NM, and October 6, 1999 in El Paso, TX.

NEPA PROCESS

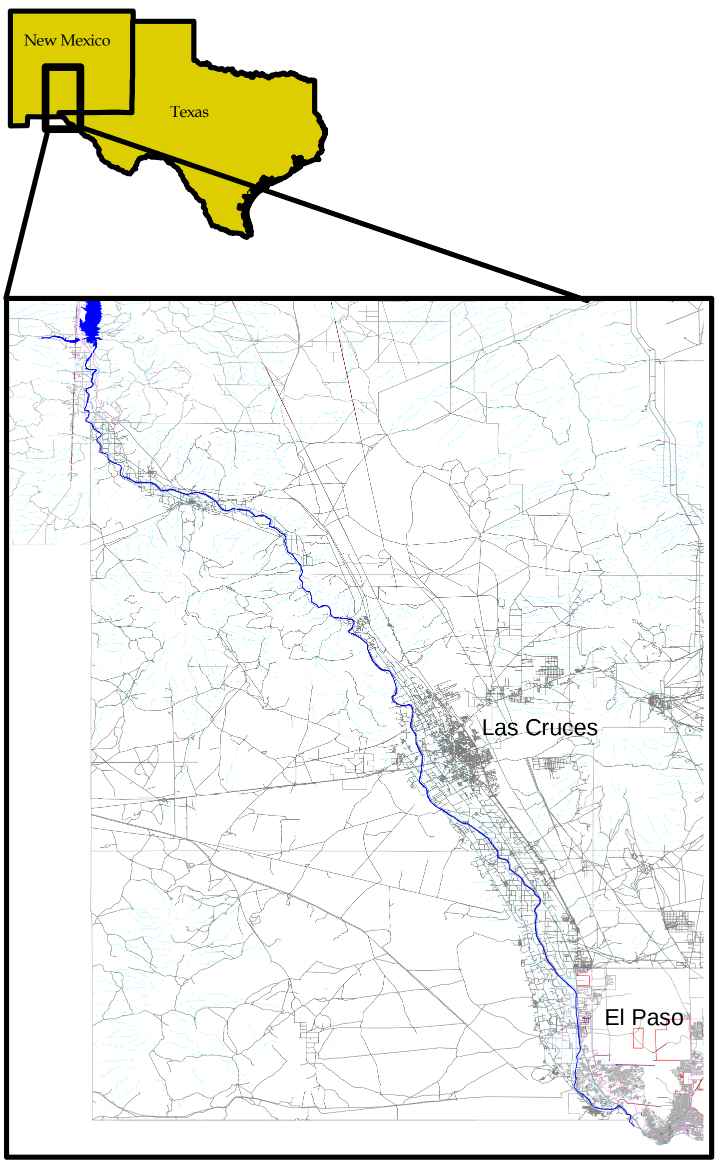
Project Definition and Review

Categorical Exclusion

Environmental Assessment

Finding of No Significant Impact

Major Federal Action



Environmental Impact Statement

Notice of Intent

Scoping

Formulation of Alternatives

Draft EIS

Public and Agency Review

Final EIS

Public and Agency Review

IBWC Decision

Record of Decision

Figure 2.1

NEPA Process

Two technical workshops were held with regulatory agencies and irrigation districts to review the alternatives formulation process and obtain input on September 12 and 13, 2000, at the USIBWC offices in El Paso. An additional public workshop was held in Las Cruces on October 12, 2000 to obtain additional public input on the alternatives development.

2.2 Environmental Assessment of the Project

In September 1977, USIBWC prepared a preliminary EIS for the annual operation and maintenance of the Canalization Project to assure compliance with NEPA requirements and consider ecological improvements. The preliminary EIS evaluated three alternatives to existing operating practices: discontinuation of all maintenance; allowing substantial vegetative growth on the floodway and channel banks; and continuation of current operations along with incorporation of an ecological management program. Adoption of the latter alternative was recommended.

In 1994 the USIBWC prepared the Rio Grande Management Plan to fulfill requirements of the Clean Water Act Section 404 permit issued by the United States Army Corps of Engineers (USACE) for dredging and fill material disposal. A mitigation plan was subsequently prepared in accordance with requirements of the Section 404 permit to establish new aquatic habitat, conduct habitat management, and monitor fish communities. The mitigation plan was then implemented according to recommendations made in October 1997 by the U.S. Fish and Wildlife Service (USFWS).

In 1998, the Southwest Environmental Center (SWEC) alleged violations of the Endangered Species Act and NEPA in correspondence addressed to the USIBWC Commissioner. On March 22, 1999, the USIBWC and SWEC signed a Memorandum of Understanding (MOU) that called for continued flood control while improving the environmental quality of the Project. The MOU sets forth the terms for preparation of an EIS for the Canalization Project, establishment of citizens' environmental forum, provisional green zones, and a tree-planting program.

In December 2000 USIBWC and El Paso Water Utilities/Public Services Board completed an EIS for the Regional Sustainable Water Project, an initiative to secure Rio Grande water as a long-term supply for the Cities of El Paso and Las Cruces. This project requires water transfer using diversion structures and aqueducts whose area of influence overlaps with that of the Canalization Project.

Because of previous initiatives, USIBWC incorporated a number of changes in operation and maintenance practices to enhance environmental conditions in the Canalization Project. Those practices are:

- Planting of cottonwoods, willows, and other native species at selected locations to enhance riparian habitat for wildlife species. This effort was initiated in the early 1970s using nursery stock, and has continued in recent years using pole plantings.

- Partial modifications of annual mowing in the floodways to selectively retain seedlings of native tree species and control development of salt cedar and other invasive species.
- Establishment of three no-mow zones, as well as tree planting areas, as part of the agreement with SWEC.
- Conducting a 3-year monitoring program to determine the effectiveness of artificial in-stream structures such as groins, vortex weirs, and embayments in enhancing fish habitat.
- Limiting sediment removal to selected sections of the Project. Dredging is conducted on an infrequent basis and, when required, has been conducted according to guidelines and mitigation requirements specified in USACE Section 404 permits.
- Encouraging development of parks and other recreational areas within lands dedicated to flood control purposes through cooperative efforts with local interests and long-term lease contracts.

2.3 Purpose and Need for the Project

River management strategies for the Canalization Project must balance the goal of enhancing environmental quality with the need to comply with the USIBWC's mission and U.S. treaty requirements. Within this context, the following goals were established for formulation of river management strategies:

- Preserve the integrity of flood control along the Rio Grande;
- Facilitate efficient water deliveries to Mexico and irrigation districts; and
- Identify environmental enhancement opportunities, such as placement of in-stream structures and improvement of riparian habitats, which will ultimately support the restoration of natural habitats and fluvial processes.

Management practices considered in the alternatives formulation process include, among others, raising and strengthening existing levees; channel modifications such as widening, armoring, and re-creation of channel meanders; placement of in-stream structures for fish habitat; vegetation management along the floodway, including removal of non-native species and maintenance of existing no-mow zones; removal of sediments from the normal flow channel and the lower end of arroyos, and maintenance of sediment control dams; and collaborative measures with other agencies and landowners to enhance native riparian and aquatic habitats, and partially restore natural fluvial processes such as over-bank flooding.

Because several actions under consideration extend beyond USIBWC's jurisdiction, a number of factors will limit the viability of proposed alternatives for operation and maintenance of the Canalization Project. Some of those factors are:

- Flow regulation is a major modification of the Rio Grande associated with operation of the Elephant Butte Reservoir. The reservoir, pre-dating the Canalization Project, is operated independently of USIBWC by the U.S. Bureau of Reclamation (USBR) to meet the needs of irrigation districts in New Mexico and Texas.

- Levees constructed as part of the Canalization Project allowed development of agricultural lands in areas of native riparian habitat formerly subject to periodic flooding. For the most part, those areas are privately held. USIBWC land ownership is largely confined to the relatively narrow floodway between the levees.
- Stream flow regime modifications and development of riparian habitats are likely to require the acquisition of water rights or agreements with irrigation districts because all Rio Grande water is entirely allocated, including agricultural return flows.
- Congress allocates funding for operation and maintenance of the Canalization Project on a year-by-year basis. Availability of funding will play a major role in determining the long-term feasibility of implementing environmental enhancements.
- Watershed-based enhancements, such as sediment and flow control measures in tributary arroyos outside USIBWC right-of-way, will require cooperative agreements and concerted efforts of multiple federal, state, and regional agencies, and private sector participation.

2.4 Report Organization

Subsequent sections of this Alternatives Report are organized as follows:

- Section 3 presents the physical description the project, current maintenance activities and habitat enhancement measures, as well as the environmental setting and causes for its degradation. This is a description of the "No-Action Alternative" the evaluation of which is required by NEPA. This information serves as the basis for comparison of current practices with proposed alternatives.
- Section 4 presents the process adopted for formulation of alternatives, and preliminary selection of alternatives.
- Section 5 describes the theoretical basis for river enhancement and restoration, as well as environmental criteria used for evaluation of the alternatives.
- Section 6 presents the geographic division of the Project area into river management units, methodology used for selection of potential enhancement sites, and a description of the enhancement locations.
- Section 7 describes characteristics of five river management alternatives selected for analysis.
- Section 8 presents an evaluation of the Project functionality in terms of flood control.
- Section 9 describes the alternatives selection process and the rationale for selecting the preferred alternative.

SECTION 3
PROJECT DESCRIPTION

This section describes the Canalization Project in terms of its physical layout and the operation and maintenance procedures utilized by USIBWC within the Project boundaries. The environmental characteristics of the Project are also presented. These descriptions provide a baseline of river management activities for comparison to alternative strategies to be evaluated for environmental impact. Current conditions are considered to be the no-action river management alternative because they represent no change from the current river management plan.

3.1 Location and Physical Description

The Rio Grande Canalization Project extends 105.4 miles from south of Percha Dam in Sierra County, NM to the American Diversion Dam in El Paso, TX. It is the northern component of the USIBWC El Paso Rio Grande Project and covers a total of 11,090 acres. The Canalization Project was constructed and is operated pursuant to an Act of Congress approved June 4, 1936, 49 Stat. 1463 (USIBWC 1977). Figure 3.1 shows the Project area. An enlarged drawing is included as Appendix E.

3.1.1 Water Delivery

The Project consists of a channel that was excavated through the historic floodplain of the Rio Grande below Percha Dam. The channel varies in width from 175 to 300 feet and has a depth of 2 to 3 feet in the lower reaches and 7 to 10 feet in the upper reaches (USIBWC 1972). The channel banks along most of the river are armored with rock revetment to reduce erosion and help maintain a consistent channel alignment. The alignment of the channel constructed in 1936 removed a few bends and meanders from the former river's path, slightly reducing the overall stream length (Baker 1943).

The slope of the channel averages 0.00075 feet per foot with a maximum of 0.0023 feet per foot over a 1-mile reach. Figure 3.2 shows the elevation change and slope of the channel bed versus distance above (north of) American Dam.

The channel has a hydraulic carrying capacity ranging from 2,500 to 3,000 cubic feet per second (cfs) in the upper end to 1,000 to 1,200 cfs at the lower end. This capacity is sufficient to convey normal irrigation flows to the Elephant Butte Irrigation District (EBID), the El Paso County Water Improvement District No. 1, and Mexico. Figure 3.3 shows the average flow in the river below Caballo Reservoir during the course of the year. Figure 3.4 shows the average water velocity in the river with irrigation flows.

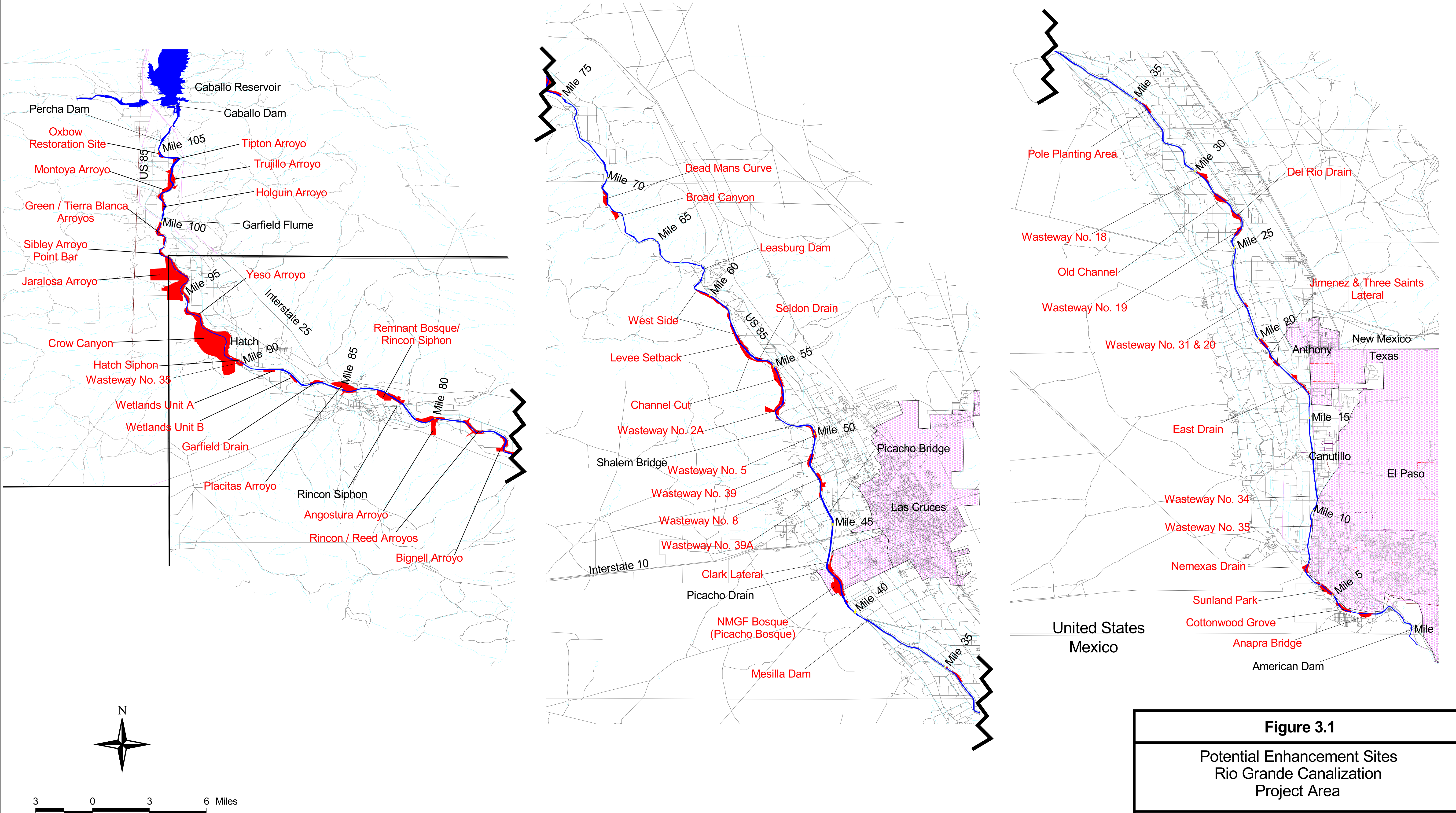


Figure 3.1

Potential Enhancement Sites
Rio Grande Canalization
Project Area

PARSONS ENGINEERING SCIENCE, INC.

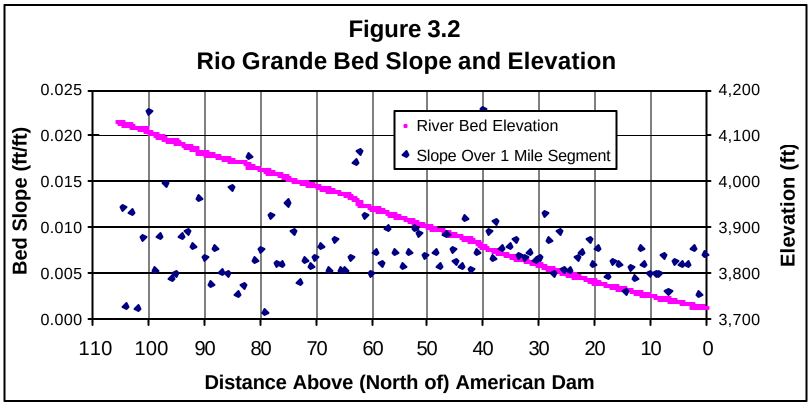


Figure 3.2 Rio Grande Bed Slope and Elevation

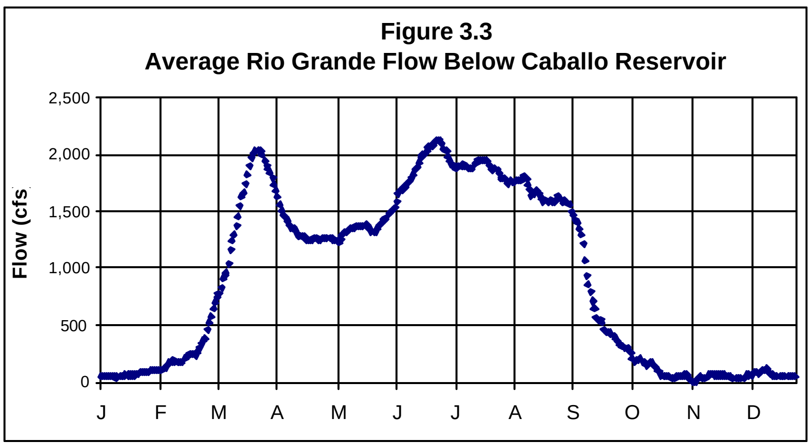


Figure 3.3 Average Rio Grande Flow Below Percha Dam

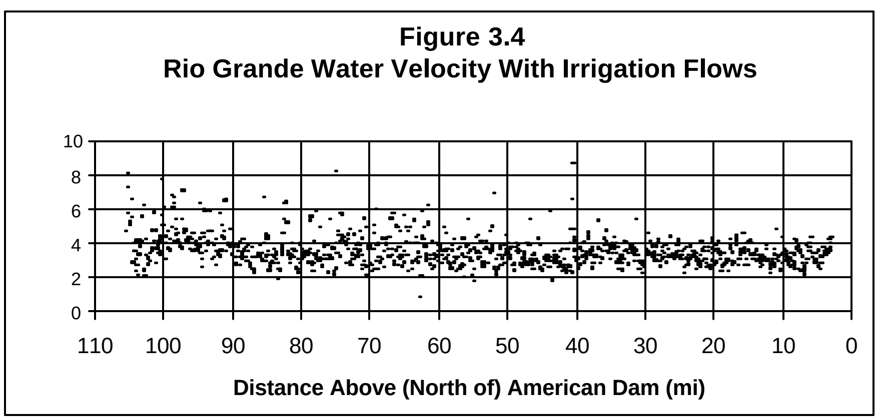


Figure 3.4 Rio Grande Water Velocities with Irrigation Flows

<u>Diversion Dams and Drainage Canals</u>

There are three diversion dams located within the Project: Leasburg Dam, Mesilla Dam, and American Dam. The dams contain gate structures to divert irrigation water into adjacent canals. Excess water overtops the dams and continues downstream. Figures 3.5 and 3.6 show photographs of Leasburg and Mesilla Dams, respectively. The canals leading from the diversion dams provide irrigation water to surrounding agricultural land by way of a wide network of canals and laterals.

Water is removed from the agricultural land by a series of drainage canals and wasteways that eventually flow back into the Rio Grande. The drains and wasteways enter the USIBWC right-of-way by passing through the flood protection levees. Some drains are equipped with gate valves or control structures at the levee crossing that regulate water level in the drains. The gate valves and control structures are designed to be closed during a flood to prevent water from backing into the canal system and flooding land outside the levees.

<u>Siphons</u>

In addition to the diversion dams and canals, there are five water-conveyance structures that cross the USIBWC right-of-way and Project channel. Three siphons, known as the Rincon, Hatch, and Garfield siphons, convey water from canals on one side of the river to the other. A fourth siphon, the Montoya siphon carries drainage water and runoff under the river to the drainage canal flowing through southern El Paso. The siphons were constructed to pass below the bed of the river. The fifth structure, the Picacho flume, consists of two elevated 42-inch diameter pipes supported by concrete piers on top of timber piles that cross the floodway and channel to convey irrigation water from east to west.

Two of the siphons, Hatch and Rincon, are protected from erosion by boulder dams across the Project channel that create a quiet backwater area of low velocity water behind the dam and dissipate the energy of the water flowing over and down the face of the boulders. Figure 3.7 shows the boulder dam protecting Hatch siphon.

3.1.2 Flood Protection

The channel is positioned between flood control levees extending for 56 miles along the west side and 74 miles on the east. Naturally elevated bluffs and canyon walls contain flood flows along portions of the Project that do not have levees. The levees range in height from about 3 feet to about 18 feet and have slopes of about 3 to 1 on the river side and 2.5 to 1 on the "land" side. The levees have a crown width of 20 feet with a gravel maintenance road along the top.

The levees were built from materials excavated from the river channel cutoffs. In many places, only sandy material was available for levee construction. Clay was hauled from off site for levee slopes and crowns. Without further investigation and testing, the current structural integrity of the levees is uncertain.

Figure 3.5 Photograph of Leasburg Dam

Figure 3.6 Photograph of Mesilla Dam

Figure 3.7 Photograph of Boulder Dam Protection Hatch Siphon

Figure 3.8 Photograph of Levee and Floodway

The levees are positioned on average about 750 to 800 feet apart north of Mesilla Dam and 600 feet apart south of Mesilla Dam. The floodway between the levees is generally level or uniformly sloped toward the channel. The floodway contains mostly grasses, some shrubs, and widely scattered trees. The bank of the channel at the immediate edge of the floodway is typically vegetated with a narrow strip of brush and trees. The design flood flow in the Project ranges from 20,000 cfs at Leasburg Dam to 17,000 cfs at El Paso. Levees were originally built to provide 3 feet of freeboard during the design flood in most reaches. Figure 3.8 shows a photograph typical of the floodway and levee.

3.1.3 Other Structures in the USIBWC Right-of-way

Twenty-eight bridges cross the USIBWC right-of-way along the length of the Canalization Project. Table 3.1 lists the bridges and their location in river miles north of American Dam. Natural gas, petroleum, water, and other utility lines also cross the river in various locations. Five older bridges present obstructions to design flood flows due to their span or height. This will be discussed in Section 8, Project Functionality Evaluation.

Table 3.1 Bridges Crossing Canalization Project

Bridge	Location
Arrey Highway Bridge	104.2
Garfield Bridge (US 85)	100.5
Salem Bridge (NM 391)	88.7
Hatch Bridge (US 85)	87.0
Hatch Bridge (NM 26)	85.1
Atchison, Topeka, and Santa Fe Railroad Bridge	82.9
Hatch - Rincon Bridge (NM 140, State HWY 154)	82.8
New Rincon Bridge	79.0
Tonuco Bridge	74.3
Leasburg Bridge (US 85)	62.0
Shalem Bridge	52.3
Picacho Bridge (U.S. 70, 80, 180)	46.6
Interstate 10 Bridge	45.3
Mesilla Bridge (NM3 359)	43.4
Santo Tomas Bridge (NM 28)	37.8
Mesquite Bridge (NM 228)	33.6
Vado Bridge (NM 28)	29.0
Berino Bridge	25.3
Old Anthony Bridge	22.2
New Anthony Bridge (NM 225)	20.3
Vinton Bridge	16.8
Canutillo Bridge	13.5
Borderland Bridge	11.4
Artcraft Bridge (TX 178)	10.9

Bridge	Location
Country Club Bridge (TX 260)	8.5
Anapra Bridge (NM 498)	3.1
Courchesne Bridge (NM 273)	1.9
Brickplant Bridge	0.3

3.1.4 Watershed of Canalization Project

The total watershed area draining to the Canalization Project below Percha Dam is 823 square miles at Leasburg Dam, 875 square miles at Mesilla Dam, and 921.6 square miles at American Dam (USACE 1996). There are numerous arroyos feeding into the Project. Table 3.2 lists the major arroyos, the location of their confluences with the Project, and the drainage area of the arroyo. Other miscellaneous sub-drainage areas also flow into the Rio Grande. In addition to contributing water to the channel flows, the arroyos deposit sand, gravel, and boulders, which decrease the carrying capacity of the channel. Between 1969 and 1975, the Soil Conservation Service (SCS), at the request of the USIBWC, constructed sediment control dams on four tributaries flowing to the Project to decrease the sediment load. These tributaries are Broad Canyon, Crow Canyon, Green Arroyo, and Jaralosa Arroyo.

Additional sediment control dams and flood control dams have been built on numerous arroyos draining into the Project. Table 3.2 also shows the dams constructed within watersheds draining to the Canalization Project. Drainage into the Canalization Project will be discussed in Section 8, Hydrologic Modeling.

Table 3.2 Drainage Areas Flowing to Canalization Project

Name	Drainage Area (mi^2)	Dam	Confluence Location (miles above American Dam)
Nordstrom Arroyo	16.7	x	103.1
Trujillo Canyon	52.9		103.1
Montoya Arroyo	23.0		101.8
Green Canyon	35.6	x	100.4
Tierra Blanca Creek	68.2		100.4
Sibley Arroyo	27.2		98.9
Berrenda Creek	87.4	x	97.4
Jaralosa Arroyo	6.8	x	95.2
Yeso Arroyo	9.5		94.9
McLeod Arroyo	14.2	x	93.9
Arroyo Cuervo	126.2	x	93.5
Reed-Thurman Dam Drain	3.25	x	83.0
Placitas Arroyo	34.6		85.7
Spring Canyon	7.4	x	80.2

Name	Drainage Area (mi^2)	Dam	Confluence Location (miles above American Dam)
Ralph Arroyo	2.5	x	80.2
Angostura Arroyo	8.9		80.2
Rincon Arroyo	124.7		78.9
Reed Arroyo	9.6		78.5
Bignell Arroyo	8.9		76.2
Buckle Bar Canyon	2.1		67.6
Broad Canyon	68.0	x	67.6
Foster Canyon	11.0		64.5
Faulkner Canyon	25.0		63.8
Doña Ana Arroyo	6.9	x	51.2
Doña Ana N. Arroyo	2.2	x	51.2
Apache Canyon	7.8	x	49.8
Box Canyon	8.7	x	49.8

3.2 Operation and Maintenance Activities

Project maintenance is described in the USIBWC's operation and maintenance manual (USIBWC 1972). More recently, the Rio Grande Management Plan was developed with a detailed discussion of the USIBWC's operation and maintenance procedures (USIBWC 1994). These manuals cover the current operation and maintenance procedures for the Canalization Project and other El Paso Rio Grande Projects. Maintenance activities are undertaken to ensure that the flood control and water delivery objectives of the Project can be met.

The two primary locations from which USIBWC operation and maintenance for the Project are carried out are located in El Paso, TX and Las Cruces, NM. The USIBWC regularly patrols the Project area from these locations and focuses inspections prior to the flood and irrigation season of early March through September. Similarly, engineering surveys are performed regularly to identify potential sediment accumulation problem areas. During and after all flood events, the channel itself is inspected for bank sloughing, washing or erosion. If problems are identified, immediate corrective action is taken.

3.2.1 Maintenance of Pilot Channel

There are numerous structures associated with agricultural irrigation and drainage throughout the length of the Project that fall under different jurisdictions, including the USIBWC, other federal agencies, and state and local authorities (e.g., the EBID and El Paso County Water Improvement District No. 1). The channel is operated by the USIBWC based on USBR irrigation operations and based on containing natural uncontrolled flows. Routine flows are controlled by operation of the river channel and diversion structures in coordination with the USBR and irrigation districts. Though the main channel, irrigation canals, and associated structures must be maintained year-round, the principal operational time of the channel is during the irrigation and flood season. Routine maintenance of the channel is performed during non-irrigation periods when water levels are lowest.

The rate of sedimentation from Rio Grande tributary basins flowing to the Canalization Project was estimated in a 1996 study (USACE 1996). Table 3.3 gives the average annual computed total sediment load for major arroyos sorted from high to low sediment loads. Table 3.3 indicates where channel maintenance is most frequently required.

Table 3.3
Sediment Load for Major Drainage Areas Flowing to Canalization Project

Name	Drainage Area (mi^2)	Dam	Confluence Location (miles above American Dam)	Average Annual Total Sediment Load (acre-feet)
Rincon Arroyo	124.7		78.9	33.52
Tierra Blanca Creek	68.2		100.4	22.09
Trujillo Canyon	52.9		103.1	18.88
Bignell Arroyo	8.9		76.2	16.88
Placitas Arroyo	34.6		85.7	14.91
Sibley Arroyo	27.2		98.9	13.22
Faulkner Canyon	25		63.8	12.70
Montoya Arroyo	23		101.8	12.22
Foster Canyon	11		64.5	9.06
Reed Arroyo	9.6		78.5	8.64
Yeso Arroyo	9.5		94.9	8.60
Angostura Arroyo	8.9		80.2	8.41
Buckle Bar Canyon	2.12		67.6	5.41
Arroyo Cuervo	126.2	x	93.5	3.38
Berrenda Creek	87.4	x	97.4	2.60
Broad Canyon	68	x	67.6	2.20
Green Canyon	35.6	x	100.4	1.51
Nordstrom Arroyo	16.7	x	103.1	1.06
McLeod Arroyo	14.2	x	93.9	1.00
Box Canyon	8.7	x	49.8	0.83
Apache Canyon	7.8	x	49.8	0.80
Spring Canyon	7.4	x	80.2	0.79
Jaralosa Arroyo	6.8	x	95.2	0.77
Doña Ana Arroyo	6.9	x	51.2	0.77
Reed-Thurman Dam Drain	3.3	x	83.0	0.61
Ralph Arroyo	2.5	x	80.2	0.56

The USACE also performed a study on the scour and deposition of sediments within the main channel (USACE 1996b) using HEC-6 modeling. The study evaluated the extent of bed elevation changes resulting from low, high, and 100-year flows in the channel. The study concluded that low flow conditions over the course of a year would result in only minor scour and deposition along the river. Changes ranged from a maximum deposit of 0.7 feet to maximum scour of 1.7 feet.

Bed elevation changes increased for the high flow case with a maximum deposition of 1 foot to a maximum scour of 2.6 feet over the course of a year. Modeling for low and high annual flow conditions did not include effects of sediment contributed by the arroyos.

For 100-year flows, scour and deposition values were generally less than 1 foot except at bridges and tributary inflow locations. Significant deposition (greater than 5 feet of sediment) was predicted for channel cross sections downstream from Rincon Arroyo, Trujillo Canyon, Tierra Blanca Canyon, Placitas Arroyo, and Faulkner Arroyo.

The main channel of the Project is maintained to remove debris and deposits, including sand bars, weeds, and brush growing along the bed and banks. Any major depositions or channel closures caused by sediment loads from arroyo flows are removed. Channel excavation is performed with bulldozers or draglines either from the channel bank or from within the channel. Normal maintenance work on the main channel is conducted during the non-irrigation and flood seasons from September 15 to March 1. Islands and sandbars with vegetation may remain in place as long as the river’s carrying capacity is not significantly affected.

It is also the responsibility of the USIBWC to maintain the grade of the channel bed at the mouth of the arroyos to ensure the channel conveys irrigation deliveries. This sediment removal is normally accomplished with tractor scrapers and draglines between September and March. However, if the channel becomes plugged because of extreme sediment loads from an arroyo, the Project Superintendent will also use other equipment, such as bulldozers and backhoes, necessary to remove the barrier materials and restore the carrying capacity of the channel.

Sediment collected from channel excavation, arroyo mouth maintenance, and other sediment control efforts is deposited on the floodway, on upland spoil areas, or on other federal or private lands approved for this purpose.

3.2.2 Maintenance of Floodways

The floodway areas outside the main channel but between the flood control levees are maintained to remove obstructions. Mowing of the floodway controls weed, brush, and tree growth, and is conducted at least once each year prior to July 15. Farm tractors with rotary slope mowers are generally used to mow the floodways. Draglines or marden cutters are also used to clear the grass. The channel banks and floodways are mowed to a height of approximately 6 to 12 inches above the ground. Some portions floodways are leveled prior to mowing using a motor grader, scraper, bulldozer, or similar machine. Some areas with dense vegetation may require a second late summer mowing. Figure 3.9 shows a photograph of the USIBWC mowing operations.

Placement of additional riprap to protect erodable banks and meandering channels is considered part of the annual maintenance. Any scouring or gouging of the floodway due to flooding is repaired as soon as possible.

3.2.3 Maintenance of Levees

Levees are inspected regularly at the beginning of each flood season and immediately after each flood event. Additionally, inspections are made to confirm that no obstructions or encroachments are being made upon or against the levees. Maintenance includes encouraging grass growth on the levee slopes for erosion control, cutting brush and tall weeds from the slopes, and repairing levee slopes. Levee slopes are mowed to prevent growth of brush and trees that could cause an obstruction to flows (Figure 3.9). Mowing also facilitates visual inspection to determine any negative effects during floods. The levee slopes are mowed with the same specifications as the floodway.

Levee roadways are generally unpaved gravel roads designed for passage of operation and maintenance personnel and equipment. Though the USIBWC has locked gates and posts signs to discourage trespassing and encroachment, there is unauthorized use that is difficult to control. Part of levee maintenance includes road grading and road resurfacing with gravel as needed. The entire levee road system for all the El Paso Rio Grande Projects is resurfaced within a 20-year cycle.

The USIBWC administers a land lease program in the Project area. Currently, 3,552 acres within the Project area are leased. Agricultural and grazing leases require that brush and vegetation be removed or mowed annually within the floodway portions of the lease. Additionally, no permanent structures may be constructed. By leasing land within the floodway, the need for mowing by USIBWC is eliminated. Table 3.4 lists the floodway acreage leased in each section of the Canalization Project (Smith, 2000).

Table 3.4 Floodway Acreage Leased in the Canalization Project.

Project Section	Leased Area (acres)
Rincon Valley	2,384
Seldon Canyon	0
Mesilla Valley	1,099
El Paso (South of Vinton Bridge)	69
Total Area Leased	**3,552**

Figure 3.9 Photograph of USIBWC Mowing

Figure 3.10 Photograph of Pole Planting

USIBWC collects a nominal annual fee for leased land except for leases to the municipalities of Mesilla, Las Cruces, and Sunland Park, NM. USIBWC maintenance personnel perform visual inspections of land use and grazing practices to assess adverse impacts due to erosion. However, the USIBWC has no written standards or guidelines to define the appropriate intensity of grazing in the floodway.

3.2.4 Maintenance of Drains and Siphons

The Project includes a variety of structures designed for purposes of irrigation, drainage, grade control, diversion, siphoning, and traversing (e.g., bridges). These structures are composed of concrete, metal, timber, and fabric and must be maintained to insure adequate performance. Drainage and irrigation structures in the Project area are licensed by the USIBWC to other entities. The USIBWC Project Superintendent must confirm that the licensee adequately maintains structures. Maintenance inspections confirm that all pipes, gates, operating mechanisms, revetments, concrete, steel, and timber are in good working condition. Additionally, all inlet and outlet channels to structures must be kept open and free of debris, and blockage and sediment are not allowed to accumulate in or near the structures. Critical maintenance is performed as needed, and normal maintenance such as cleaning and painting, is conducted during the non-irrigation and flood season (September 15 to March 1). Flap gates and manual gates and valves are oiled and examined periodically. Maintenance personnel must control and repair seepage, sloughing, and scouring near structures as this may lead to structural failure.

EBID operates and maintains the Hatch and Rincon Siphons. The siphons are subject to erosive forces that will impact the integrity of the structures if not controlled. There are two siphons equipped with erosion control structures within the Canalization Project. EBID protects the siphons by maintaining slow-moving backwater with riprap dams across the channel at the siphon crossings. Periodically, boulders are added to reinforce the dams when excessive flows damage the structure. USIBWC is currently studying erosion control measures at the siphons, and at the Picacho flume.

The bridges over the Rio Grande in the Canalization Project area are licensed by the USIBWC to other federal, state, and non-federal agencies for operation and maintenance. The USIBWC Project Superintendent is responsible for confirming that licensees are adequately maintaining the bridges.

3.2.5 Maintenance of American Diversion Dam

There are three principal diversion structures in the Project operated and maintained by the USBR: Percha Dam, Leasburg Dam, and Mesilla Dam. The American Diversion Dam, defining the southern boundary of the Project, is operated by the USIBWC. American Dam is equipped with automatic opening and closing devices pre-set for various stage heights. Maintenance of the dam generally consists of cleaning, painting, and replacement or repair of damaged or lost parts and equipment. Normal maintenance of American Dam is performed during the non-irrigation season.

Inspections of the dam are performed prior to the irrigation season and during and after flood events. Water flows, which are slated for delivery to Mexico, are routed past the American Dam and diverted to Mexico downstream at the International Dam.

3.2.6 Maintenance of NRCS Dams

The USIBWC is responsible for maintaining four NRCS sediment control dams and associated access roads. This maintenance includes mowing discharge canal slopes, cleaning and maintaining trash racks, maintaining intakes and outlets, and repairing fences. Maintenance work is generally done annually following joint inspections by personnel from USIBWC, NRCS, and EBID.

3.3 Habitat Enhancement Measures

3.3.1 No-Mow Zones

The USIBWC has established three provisional no-mow zones along the Canalization Project where maintenance is minimized and mowing has been reduced or eliminated. Grazing of cattle continues in some of these areas. The USIBWC retains the authority to conduct necessary emergency maintenance in these areas. These no-mow zones are serving as study areas to demonstrate the effects of additional vegetation growth on the functions of the Project. The first green zone is from Percha Dam to Doña Ana County line and extends for 7 miles on each side of the channel. There are no flood protection levees within this portion of the Project.

The second green zone is in Seldon Canyon and runs 8 miles on each side of the channel. The jurisdiction of USIBWC is limited to the channel bed throughout the canyon. There are no levees or floodways that the USIBWC has responsibility for maintaining. The USIBWC, historically, has not mowed vegetation in the area.

The third green zone extends 5 miles on each side of the channel within the floodway from Shalem Bridge to Picacho Bridge. The no-mow zones consist of areas 800 feet long by 35 feet wide parallel to the channel. The no-mow zones are located from 10 to 35 feet from the channel bank and are separated by 100-foot long mowed areas. To serve as control sites, areas 400 feet upstream and downstream of the no-mow zones are still mowed, as are areas beyond the 35-foot wide no-mow zones. Cottonwood trees have also been planted near and within these areas. Vegetation within no-mow zones that could impact flood protection may be subject to removal.

3.3.2 Tree Planting

USIBWC, in coordination with volunteer organizations, plants trees within the floodway. Planting is typically done with cuttings of branches or poles from cottonwood (*Populus* spp.) and willow (*Salix* spp.) trees. The poles are put into holes dug in the floodway to the water table, which allows the trees to establish roots. Individual trees are planted in widely separated locations to avoid potential impacts on flood flows. Figure 3.10 shows cottonwood pole plantings.

3.3.3 Aquatic Habitat

USIBWC constructed and is monitoring aquatic habitat enhancement measures within the channel as mitigation for dredging sediments near the mouths of several arroyos. Three types of enhancements were constructed to provide habitat for aquatic organisms by creating low water velocity conditions. These enhancements are embayments, rock groins, and vortex weirs.

Embayments

Embayments were constructed in three locations by excavating an area about 50 feet by 100 feet into the floodway that opened into the channel. One embayment was constructed with boulders at its opening to the channel for sediment control. The embayments were constructed near the locations where Trujillo, Jaralosa, and Rincon Arroyos intersect with the Rio Grande and were intended to provide calm or low-velocity water for fish and other aquatic species.

Rock Groins

Backwater areas in the channel created by sediments from arroyos are eliminated during dredging operations. Rock groins are designed to mitigate this loss of habitat. Rock groins consist of boulders placed in a row perpendicular to the channel bank and extending about 20 feet into the channel flow. Eight rock groins were placed near arroyo mouths along the Project. Various positions relative to the arroyo mouth were utilized to determine differences in effectiveness. The groins are intended to simulate the effect of sediments that enter the channel from the arroyos. Figure 3.11 shows a photograph of a rock groin.

Vortex Weirs

Vortex weirs are structures built with boulders across the channel in the shape of a "vee". The "vee" is typically pointed upstream and is lowest in the middle of the channel and highest at the channel banks. The purpose of the weir is to create backwater habitat near the banks of the channel. Two weirs were constructed near Montoya Arroyo and near the Green / Tierra Blanca Arroyo intersection. Figure 3.12 shows a photograph of a vortex weir (with "vee" pointing downstream in this case). These structures appear to be effective in producing the desired hydraulic flow patterns.

3.4 Environmental Characteristics

The environmental characteristics of the Project provide the basis for environmental actions by defining what potential exists for different types of habitat within and near the rights-of-way.

Figure 3.11 Photograph of Rock Groin

Figure 3.12 Vortex Weir

3.4.1 Vegetation - Predevelopment Period

When the Spanish explorers arrived in the 16th century, the bank, sand bars, and adjacent floodplain areas of the Rio Grande were vegetated with scattered bosques of varying-age valley cottonwood, with a willow and salt grass dominated under story (Scurlock 1998). Fossil evidence traces the bosque community back two million years (Crawford *et al.* 1996). Bosques were dynamic, growing, and spreading when weather was favorable, and dying off during periods of prolonged drought or prolonged floods. The communities ranged from old growth to pioneer species and provided varied and diverse habitat for native wildlife.

Open, grassy areas, or vegas, were also present. Cattails and other wetland species grew in and around ponds, marshes, and swampy sites. Other major plants associated with bosques included New Mexico olive, baccharis, false indigo bush, wolfberry, and in southern reaches, mesquite. All these plant communities were considerably modified by human activity during the historic period (Crawford *et al*. 1996 and Dick-Peddie 1993).

Wetlands were abundant in the Rio Grande floodplain, evidence of a shallow water table and dynamic shifting river. Accounts from the 19^{th} century document the presence of marshes and lakes in the vicinity of the Canalization Project area (Stotz 2000).

Numerous floods resulting in a highly variable river channel characterized the flow regime. Snowmelt, widespread summer rains, and localized heavy thunderstorms caused floods (Scurlock 1998). The river course frequently changed, meandering throughout the valley. Minor lateral shifts were frequent and even large-scale changes in the channel occurred. Channel width varied considerably, historical reports described the river width ranging from 600 feet wide to virtually a trickle full of sandbars (Stotz 2000).

3.4.2 Hydrology

The flow of the Rio Grande originates from watersheds in the southern slopes of the Colorado mountains and the mountain ranges of northern New Mexico. This water is stored at Elephant Butte and Caballo Reservoirs. The water is used to irrigate the Mesilla, El Paso, and Juarez Valleys.

The water released from Elephant Butte Reservoir has averaged 682,000 acre-feet annually. A large portion of this flow (~495,000 acre-feet) is diverted to irrigate croplands in New Mexico. The remainder and return flow then reach El Paso at an annual rate of 443,000 acre-feet. As the flow reaches American diversion dam, 269,000 acre-feet are diverted annually to the American Canal, which is the main supply canal for the El Paso Valley. The 1906 convention specifies that 60,000 acre-feet per year be diverted to Mexico to irrigate the Juarez Valley.

The Elephant Butte Reservoir operations are based on average historic losses and evaporation rates for Elephant Butte and Caballo Reservoirs. Scheduled outflow from

Elephant Butte and Caballo are based on average irrigation demands for years with a full water supply.

3.4.3 Geomorphic Characteristics

Physically, the channel is engineered with vertical sides rather than the more sloped channel banks of a developed natural stream. Any excavation of the channel to maintain the engineered configuration discourages establishment of vegetation cover and root mass that would normally stabilize a stream bank. Furthermore, channel bank hardening, river training works, and upstream flow regulation at Elephant Butte Dam have kept the channel from developing the meanders and ponded characteristics historically documented. The plant community in the Canalization Project area is maintained at a state similar to early successional riparian communities. The practice of leveling the floodway encourages invasion of cleared areas by pioneer species or invasive plants such as salt cedar (*Tamarix ramosissima*) and Russian thistle (*Salsola kali*). Mowing suppresses woody vegetation in the floodplain.

3.4.4 Current Vegetation Communities and Classification System

The Chihuahuan Desert is subdivided into three regions (Schmidt 1979, Henrickson and Straw 1976, Brown 1982): the northern Trans-Pecos region, the middle Mapimian region, and the southern Saladan region (MacMahon 1988). The Project is included in the northern Trans-Pecos region of the Chihuahuan Desert.

The Trans-Pecos region of the Chihuahuan Desert is historically a mosaic of grasslands and desert shrub lands (Burgess 1995, MacMahon 1988, McClaran 1995). Tobosa (*Hilaria mutica*), black grama (*Bouteloua eriopoda*), and other grass species dominate the grassland communities. Desert shrub species are primarily creosote bush (*Larrea tridentata*) or tarbush (*Flourensia cernua*). Riparian vegetation is dominated by willows (*Salix* spp.), cottonwood (*Populus* spp.), and mesquites (*Prosopis* spp.) with contributing species including ash (*Fraxinus* spp.) and desert willow (*Chilopis linearis*). Recently, invasive salt cedars (*Tamarix* spp.) have attained dominance in the majority of riparian communities.

Vegetation communities in the Project area are primarily disturbance-type communities, generally dominated by invasive exotic plant species. Species composition in these communities is related to river proximity. A border of hydrophytic vegetation, generally 10-15 feet wide, occurs on the river bank forming the sloped side of the channel. This narrow riparian zone is dominated by salt cedar with occasional seep willow (*Baccharis glutinosa*), willow (*S. gooddingii*), or herbaceous vegetation including common reed (*Phragmites australis*), sedges (*Carex* sp. and *Schoenoplectus* sp.), and rushes (*Juncus* sp.). Isolated wetlands are found along the river channel, wasteways, and low-lying areas within the floodplain. Salt grass (*Distichlis spicatai*) is the common grass occurring in wetland sites.

A modified version of the Texas Parks and Wildlife Department (TPWD) vegetation classification system (Hinson and Pulich 1995) is used to describe the current land cover conditions of the Project area. Four land cover classes and six sub-classes have been defined for the Project area. The classes are upland, riparian, wetland, and aquatic. The class totals for riparian herbaceous and salt cedar fluctuate considerably and are influenced by mowing and grazing activities. An area could be classed as riparian herbaceous one year and salt cedar in two to three years in the absence of mowing. Table 3.5 gives the land cover totals. Each class is described in further detail below.

Table 3.5
Estimated Canalization Project Land Cover Totals in USIBWC Right-of-Way (Includes Seldon Canyon River Channel)

Association	Acres
Uplands	
Upland herbaceous	1,500
Upland shrub/scrub	2,200
Agricultural (non-grazing)	70
Total Uplands	**3,770**
Riparian	
Salt cedar	1,400
Willow/seep willow	180
Riparian herbaceous	3,000
Riparian woodlands	0
Total Riparian	**4,580**
Total Wetlands	**150**
Total Aquatic	**2,600**
Total USIBWC	**11,100**

Uplands Class

The upland class is adopted from the level 1 classes in the United States Geological Survey (USGS) Land Use/Land Cover Classification System (Anderson *et al*. 1976). Three major subclasses of uplands are delineated; herbaceous, shrub/scrub, and agriculture.

Upland Herbaceous Sub-Class

The majority of the Project right-of-way is classified as an upland herbaceous community. The upland herbaceous community occurs on the slopes of levees, terraces, and terrestrial uplands adjacent to the river corridor. Woody species such as salt cedar, seep willow, and honey mesquite occasionally occur. Four-wing saltbush and pale wolfberry dominate grazed areas. Mowing maintains the upland herbaceous community on levees as an herbaceous dominated community by suppressing woody vegetation growth. Designated no-mow areas (green zones) will likely evolve into a salt cedar or mesquite dominated communities in the absence of woody vegetation control.

Slopes of the levees are primarily vegetated by bermudagrass (*Cynodon dactylon*) and forbs. Russian thistle and other weeds are locally dominant. Small remnant bosques composed of native vegetation and exotic woody species are concentrated at arroyo mouths and drains.

Upland Shrub/Scrub Sub-Class

Upland shrub/scrub dominates undeveloped areas outside the floodplain. A mosaic of grasslands and desert shrub land such as creosote bush and tarbush characterizes it. Upland grasses are often intermixed. The Bureau of Land Management (BLM) lands adjacent to the river are mostly upland shrub/scrub. Higher elevations of mesquite-dominated communities are included in this sub-class.

Upland Agriculture Sub-Class

This sub-class includes herbaceous croplands, pecan orchards, and fallow fields. The majority of the agriculture lands are located in the river floodplain. Historically, much of the current agriculture areas were composed of mixed floodplain associations including mesic grasslands, cottonwood–salix, mesquite-screwbean, and wetlands communities (Stotz 2000). Although classed as upland for purposes of the Project, the agriculture class could be considered a transitional class.

Riparian Class

Riparian has been previously defined; however actual classification of the riparian systems can be problematic. Depending on the classification system, riparian habitat is classed as a terrestrial or even wetland-type community. The confusion lies in the fact that it is neither, but rather a transitional community (as are most floodplain type associations) between terrestrial and uplands. The TPWD system addresses riparian types of land cover as a transitional land separate from upland and wetland. Therefore, it has been separated out as a separate class from wetlands and uplands in this report.

The Project area hosts several types of riparian plant communities. The communities can be broadly classified into four types; salt cedar, willow/seep willow, riparian herbaceous, and riparian woodland. Currently, the riparian woodland sub-class (cottonwood-willow), historically a dominant community in the area, is non-existent except for Percha Dam State Park, a site due north of the Project area. The cottonwood-willow riparian sub-class is the community targeted for restoration and is considered a reference community of restoration actions.

Riparian Salt Cedar Community Sub-Class

The salt cedar community type occurs primarily as a 10 to 15-foot margin along the river, normally on the slope of the riverbank. Salt cedar is strongly dominant, comprising over 90 percent of live cover and in most areas is less than 10 feet in height due to mowing.

Variations of the salt cedar community are found on vegetated sandbars and portions of the river where mowing is not practical due to topographic relief. Although species composition is mixed, salt cedar dominates the majority of these sites. Several areas identified as remnant bosques (both on privately owned property and within the right-of-way) often exhibited slight variation of above description. Species such as screwbean and mesquite co-dominate with salt cedar with occasional cottonwoods.

Riparian Willow/Seep Willow Sub-Class

Although far less prevalent than the salt cedar association, willow/seep willow dominated sites are found. Common reed and bermudagrass often co-exist in willow-dominated areas. Willow/seep willow sites generally include a substantial salt cedar component that at times appears to be a co-dominant. Woody plants in the majority of willow/seep willow areas are generally less than 10 feet in height due to mowing. The willow/seep willow community type accounts for less than 10 percent of the woody dominated communities. As with salt cedar, willow/seep willow community types occur primarily as a 10 to 15-foot margin along the river and occasionally in stands on vegetated sandbars.

Riparian Herbaceous Sub-Class

A flat floodway outside the river channel extends to the edge of the levee. Upland grass species and weedy forbs, primarily bermudagrass, Russian thistle, peppergrass (*Lepidium montanum*) dominate the floodway. Native grasses such as alkali sacaton (*Sporobolus airoides*), sand dropseed (*Sporobolus cryptandrus*), and salt grass (*Distichlis spicatai*) are common. Widely scattered mature cottonwoods remaining in the floodway are often in decline.

Riparian herbaceous sites have little or no woody plants in the riparian zone mostly due to maintenance activities. Occasional variation occurs in species compositions in response to grazing pressure, water table levels, and changing soil types. Grazed areas are easily identified by the lack of herbaceous cover. In the absence of mowing, much of the riparian herbaceous community would likely transform into a salt cedar community type.

Riparian Woodland Sub-Class

Currently, the limited riparian woodland sub-class is dominated by salt cedar. The majority of salt cedar is classed as a shrub lands; however, mature salt cedar stands are found in Seldon Canyon adjacent to USIBWC lands (an indication of a future succession in the absence of salt cedar control). The mature salt cedar stands are dense monoculture woodland communities with a heavy needle-littered ground cover. There is virtually no understudy vegetation; however, the overhanging branches provided streamside structure and shading during high irrigation flows. A cottonwood-willow species association historically characterized this sub-class.

Wetlands Class

Wetlands are lands where saturation with water is the dominant factor determining soil development and the types of plant and animal communities living in the soil and on its surface (Cowardin *et al*. 1979). A characteristic feature shared by all wetlands is soil at least periodically saturated with or covered by water. The demarcation between uplands (and to a partial extent riparian) and wetlands is designated as 1) the boundary between land with predominantly hydrophytic cover and land with predominantly mesophytic and xerophytic cover, 2) the boundary between soil that is predominantly hydric and non-hydric (clear separation between uplands), and 3) the extent of saturated and flooded conditions.

In the Project area, wetlands are characterized by a high water table mostly classified as palustrine emergent wetlands and palustrine shrub/scrub (based on Cowardin *et al*. 1979). Differences between wetlands and riparian communities are often not clear. However, wetlands typically have a greater predominance of hydrophytic vegetation, water at or near the soil surface, and soils that are classed as hydric.

Aquatic Class

The aquatic class consists of open water surface areas and includes submerged lands such as aquatic beds and river substrate. Numerous factors influence characteristics of the aquatic community, including stream flow, water quality, energy sources, physical habitat structure, and biotic interactions. Quality of aquatic habitat is a function of structure and diversity, which is often correlated with a diversity of aquatic organisms. The aquatic habitat class for the Project area is characterized by low diversity in habitat types. There is very little pool/riffle structure (optimal aquatic habitat) while the majority of the river is characterized as an undifferentiated run. Water velocities averaging up to 8 feet per second are not suitable for fish habitat. Slow to moderate water velocities (0 to 1.5 feet per second) are required for spawning and juvenile life stages.

In-stream cover, which provides essential habitat for different life stages of invertebrate and vertebrate life, is practically non-existent in the Project area. The riparian zone and watershed characteristics intimately affect stream habitat. Riparian plants filter sediments and nutrients, provide shade, stabilize stream banks, provide cover in the form of large and small woody debris, and produce leaf litter energy inputs. Altered riparian zones or watershed land has detrimentally affected stream habitat. The river channel is mostly straight with little to no sinuosity except in the upper reaches of the Project area, with little variation in velocity. Sand and silt dominate the substrate and are generally the least favorable substrates for supporting aquatic organisms and support the fewest species and individuals (USEPA 1998). The river bank is moderately stable to unstable.

3.5 Ecosystem Degradation

Riparian ecosystems in the southwest (including the Project area) are declining due to anthropogenic disturbances (Szaro 1989, Briggs 1995, Briggs 1996, Crawford *et al*. 1996, Patten 1999). Degradation has been a result of direct impacts as well as the cumulative effect of numerous, indirect impacts. Activities which have negativly impacted riparian systems in the Project area mirror those throughout the southwest. Causes of decline, either separately or in combination, include altered hydrology, establishment of exotic species (e.g., *Tamarix* spp.), overgrazing, floodplain reduction, and land use practices (Everitt 1998, DeBano and Schmidt 1989, Schmidly and Ditton 1978).

3.5.1 Hydrologic Modifications

Impacts of dams and water control structures on the Project include modifications to historic hydro-periods, reduction in suspended sediments, and increased rate of channelization and incision. Altered stream hydrology has been at least one major cause of the decline of native bosques creating conditions favorable for salt cedar establishment and eventual dominance within locations previously characterized as cottonwood-willow communities (Stromberg 1998). Four interrelated but separate modifications include; 1) changes in peak flow characteristics, 2) changes in total runoff, 3) changes in water quality, and 4) changes in aesthetic characteristics.

3.5.2 Dam Construction

The construction of Elephant Butte Reservoir in 1913 ended the seasonal floods driving the dynamic equilibrium of the river. Impacts included changes in riparian communities, sediment deposition, changes in flow patterns, reduced water volume, and reduced seasonal variations. Current irrigation flows in conjunction with flood flow attenuation have severely altered the complexion of the river as well as the associated vegetation communities. Caballo Dam was constructed as a flood control structure in 1938 but has not altered seasonal downstream flows in the river.

3.5.3 Canalization

Canalization of the Rio Grande was accomplished by creating a normal flow or pilot channel for conveyance of irrigation flows and water deliveries to Mexico. The construction of a normal flow channel eliminated islands, bends, and braided channels in the floodway of the river. The Canalization Project also included hardening of channel banks to prevent reformation of meanders and bends.

Three large oxbows were cut off by the Canalization Project. In addition, other bends were straightened to reduce the river length by about 5 percent. The average river bed slope increased from 0.0703 percent to 0.074 percent as a result of the straightening.

Aquatic habitat was degraded or eliminated by the channel modifications due to loss of low-velocity backwater conditions and riparian vegetation.

3.5.4 Channel Straightening

The Canalization Project removed only a few miles of river length by straightening bends and meanders in the river. An example of channel straightening, pre-dating Canalization Project construction, occurred at the Vinton cutoff in the El Paso area. The Vinton cutoff was a flood control project that caused an 11 percent reduction in length between Vinton and Canutillo. The actual length of the river was reduced 2,000 feet; from 17,000 feet to 15,000 feet. Channel straightening at this location caused an increase in slope of the river bed of 0.0007 feet per foot, which caused an insignificant increase in water velocity and scour potential. As stated above, the construction of the Canalization Project only increased the average river bed slope by 0.000036 feet per foot over its entire length.

3.5.5 Floodplain Reduction

The floodplain area of the Rio Grande was reduced by construction of flood control levees designed to protect agricultural land and real property. This had the effect of raising the water surface elevation during flood flows and increasing the potential for flooding downstream. The reduction of the floodplain also reduced or eliminated the periodic inundation of wetland areas adjacent to the river.

3.5.6 Modification of Sedimentation Processes

Development of levees for flood control allowed for large-scale conversion of the floodplain for agricultural and development. Traditional flood control practices require maintaining levees and channels in a manner that most efficiently transfers water. As a result, a natural nutrient replenishment process once provided by flooding has disappeared.

Hydrologic processes are driven by the flow of water and sediments through the system (Stotz 2000). Extensive sediment load coupled with a low-gradient flow for much of the Project area created a braided, sinuous channel meandering through a wide floodplain. Changes in hydro-period as a result of dam operations altered sediment accumulation and reduced transportation of sediments downstream. Sedimentation is now restricted within the narrow confines of the levied channel presenting potential flood control problems only partially controlled by canalization. Sediment loads are currently managed through construction of sediment dams along arroyos in the upper Project area. Extensive deposits of sediment accumulate at arroyo mouths and diversions dams. Diversion dams reduce water velocity resulting in accumulation of sediments upstream and reduction of sediments below dams. Sediments must be removed by USIBWC to maintain the normal flow channel.

3.5.7 Land Use Changes

The term "land use" encompasses many activities that can affect stream resources directly through destruction of habitat as well as by influence on watershed processes that govern water yield, water regimen, and sediment production. Major land use changes include conversion to agriculture, grazing, urbanization, and Project maintenance practices.

Conversion to Agriculture

Agriculture is a major land use change which has the immediate effect of removing riparian habitat from the system and a systemic influence on areas outside the converted lands through water diversion, hydro-period modification (irrigation flows seasons), water quality impact, etc. Converted land historically has greater value than the natural floodplain, and additional cumulative impacts such as levee construction and arroyo water diversion (e.g. Jaralosa Arroyo) are implemented for flood protection. The storage and withdrawal of water for irrigation has played a major role in shaping the river channel and riparian area. Depletion of stream flow during the spring runoff period reduces the stream power available for transporting deposited sediments and seeds.

Grazing

Livestock grazing can impact riparian ecosystems in several ways, including altering vegetation diversity and density, stream channel morphology, water quality, and riparian soil characteristics (Kauffman and Krueger 1984).

Grazing on the floodplain impacts the aquatic habitat by increasing siltation, sedimentation, increased water temperatures (reduction of streamside vegetation), and decreased habitat quality for native fish species (Krueper 1996). Grazing contributes to the degradation of available aquatic habitat.

Cattle will forage on seedlings and saplings of many riparian woody species, including cottonwood and willow (Patten 1998). Current grazing practices impact the Project area in a variety of ways, most visibly in decreased plant diversity and biomass on sites exhibiting overgrazing. Overgrazing results in excessive removal of vegetation from the riparian areas. Without vegetation to stabilize the soil, banks may be subject to hoof shear, resulting in steep, unstable banks. In areas where periodic releases of water occur, flooding and water course trenching may further undercut the banks.

Loss of riparian vegetation results in declining water quality, increased water temperatures, increased sedimentation, and increased nutrient input to the water course (Kauffman and Krueger 1984). In addition, grazing (hoof action) can alter riparian soil structure through compaction, streamside erosion, and other impacts. Compacted soils have less water holding capacity inhibiting deep percolation of water into the soil profile (McBryde 1998).

Urbanization

Urbanization, including development of roads, buildings, other municipal or industrial structures, parking lots, etc. can have significant effects on the hydrology of a watershed. Development within the watershed directly and indirectly impacts the Project's riparian and aquatic habitats. Direct removal of vegetation is the most obvious; however, cumulative impacts to water quality and associated flood management controls to protect developed sites within the watershed are potentially the most deleterious.

Maintenance Practices

Mowing and vehicle traffic along the floodway inhibit the growth of woody species and native grasses. Overall, little vegetative diversity (species and structure) currently exists within the Canalization Project. The primary effect of mowing existing salt cedar is the temporary elimination of aboveground biomass, followed by vigorous multi-stemmed regeneration of the mowed plant. Cessation of mowing practices within salt cedar dominated sites would result in a rapid development of a salt cedar monoculture. Efforts have been made by mowing crews to avoid cottonwood saplings (volunteer regeneration and pole plantings) during seasonal maintenance activities. Surveys of several areas confirm that avoidance of cottonwood plants results in multi-year survival of some plants.

3.5.8 Invasive Species

Several species of salt cedar were introduced into the United States from southern Europe and the eastern Mediterranean region in the late 1800s. Many of these species escaped cultivation, and spread rapidly throughout the riparian areas of the southwest. Salt cedar has several characteristics that make it well suited to the desert regions of the southwest.

Salt cedar is considered a facultative phreatophyte and is able to survive in conditions where groundwater is depleted and the soil is unsaturated (DiTomaso 1998). Salt cedar can survive drought conditions longer than cottonwoods and willows, and can then rapidly respond to the presence of water (Devitt 1997) and may desiccate watercourses (Vitousek 1990, DiTomaso 1998). In addition to the ability of salt cedar to tolerate drought and saline conditions, there is some evidence that the fire regime of these riparian areas may be altered by the presence of salt cedar (Bock and Bock 1990, Smith *et al.* 1998). Salt cedar is the dominant woody species found in the Project riparian and wetlands area. It would likely dominate the majority of the floodplain replacing herbaceous communities if mowing ceased.

The Russian olive (*Elaeagnus angustifolia*) has also become established within many riparian areas of the southwest. Russian olive was introduced into the United

States in the late 1800s, and subsequently escaped cultivation (Olson and Knopf 1986). Russian olive is a rapidly growing plant with a deep taproot and extensive lateral branching (Borell 1971). The Russian olive can effectively compete with native species for space and water and is a superior competitor on bare mineral substrates due to nitrogen fixing root nodules (Plant Conservation Alliance 1997). Russian olive is considered relatively salt tolerant, although not as salt tolerant as salt cedar (Olson and Knopf 1986, Vines 1960), and is often found as a co-dominant species with willow. It is generally considered inferior to native riparian species (Olson and Knopf 1986). Russian olive is most prevalent in the northern reaches of the Project area.

Russian thistle (*Salsola kali*), also known as tumbleweed, was introduced into the United States in the late 1800s. It has colonized extensive areas within the Project boundary, particularly in disturbed sites in response to grazing and mowing. The seeds of Russian thistle are dispersed when the plant dries and wind tumbles the dried plant to a new location. Russian thistle is a particular problem in agricultural areas because of its extensive seed bank and water use. Research in croplands indicates that Russian thistle may be able to extract water from deep in the soil profile (Schillinger and Young 1999) potentially lowering the water table.

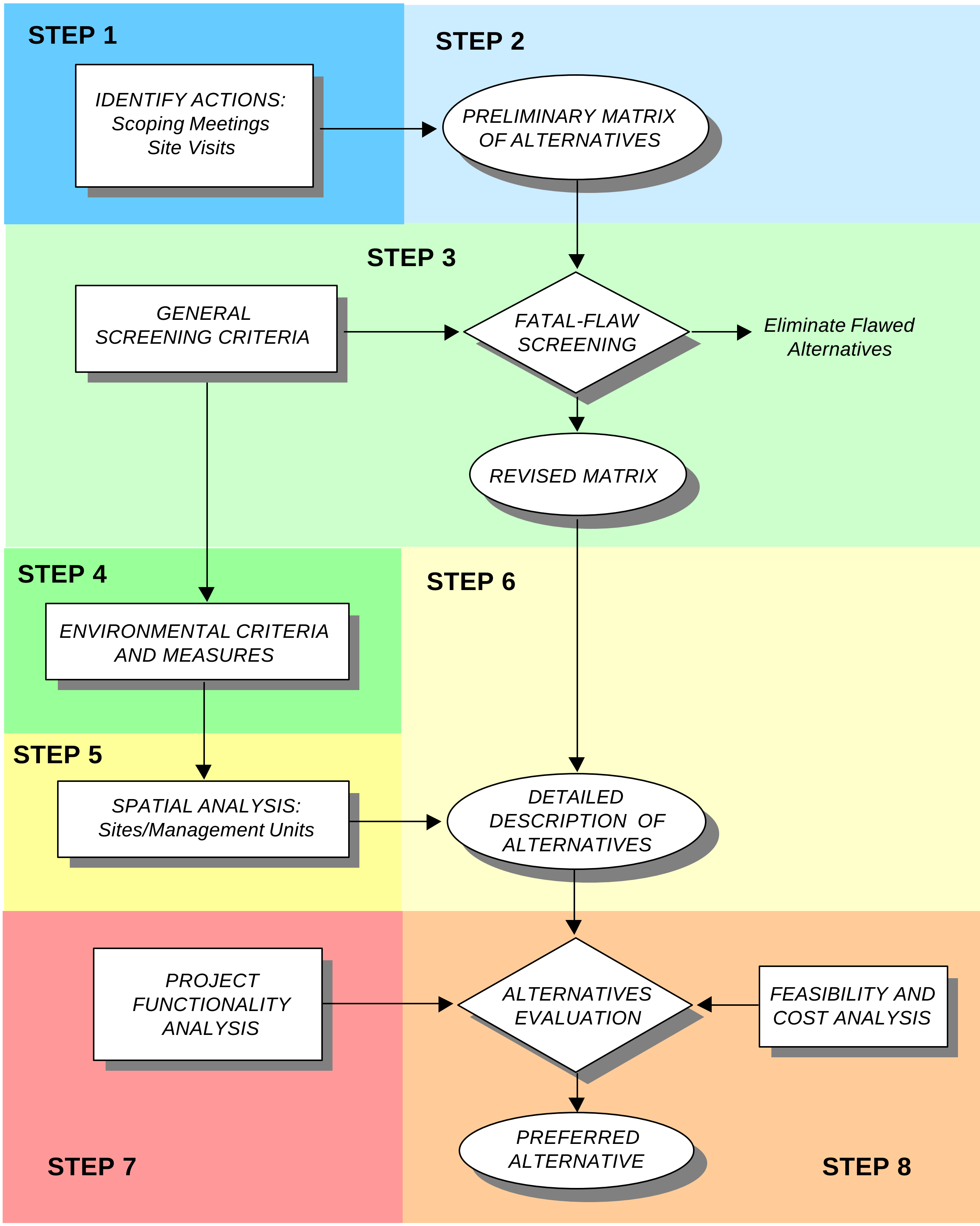
SECTION 4
FORMULATION OF ALTERNATIVES

4.1 Formulation and Selection Process

A stepped process was adopted for development of management alternatives for future operation and maintenance of the Canalization Project. The process started with the conceptual identification of seven preliminary alternatives, and continued with subsequent screening based on functionality, feasibility, and potential for environmental enhancements as the objectives. Five alternatives were retained and subsequently refined using environmental criteria and analysis of potential enhancement sites. The alternatives were then evaluated on the basis of cost and non-cost factors, including Project functionality, for selection of a preferred management alternative for the Canalization Project. Figure 4.1 illustrates eight general steps of the alternatives formulation and evaluation process. These steps, described in subsequent sections of this report, are as follows:

1. Identification of potential actions taking into account input by USIBWC and issues and concerns stated by regulatory agencies and the general public during two scoping meetings conducted in November 1999 (Section 4.2). Information on possible locations for environmental enhancements was also gathered from previous reports, maps, aerial photographs, and site visits.
2. Preparation of a preliminary matrix of alternatives identifying possible management strategies developed as combinations of proposed actions listed in Step 1 (Section 4.3). This matrix was reviewed jointly with USIBWC.
3. Initial screening of alternatives based on general objectives of functionality, feasibility, and potential for environmental enhancements (Section 4.4). Based on numerical scores or professional judgment, alternatives which did not satisfy objectives were eliminated (fatal flaw analysis), and a revised matrix of alternatives was developed. The refined matrix was then reevaluated with USIBWC and subsequently discussed in technical workshops with regulatory agencies and non-governmental organizations.
4. Selection of environmental criteria for further evaluation of the alternatives (Section 5). The concept of a habitat unit (HU) was introduced as a specific measure of enhancement potential.
5. Identification and mapping of locations for proposed actions under each alternative based on existing documentation and site-specific inspections (Section 6). The Project area was subdivided into seven geographically-distinct reaches or management units.
6. Detailed description of the alternatives based on the amount and type of habitat produced (habitat units) and spatial distribution of enhancement sites (Section 7).

Figure 4.1 Alternatives Formulation Process



7. Evaluation of the compatibility of proposed actions with the Project's requirements for flood control using hydraulic modeling (Section 8). Flood control features were added, or alternatives modified, as necessary to satisfy the premise of maintaining flood control throughout the Project.
8. Final evaluation for selection of a preferred alternative (Section 9). The evaluation assessed effects of the alternatives in terms of modified operation and maintenance, cost, required implementation effort, and performance of proposed environmental actions.

4.2 Identification of Potential Actions

4.2.1 Initial List of Actions to Modify Management Practices

A list of possible actions to modify management practices of the Canalization Project was compiled based on information from the following sources:

- Actions specified by USIBWC in the statement of work for current operation and maintenance and future construction;
- Actions suggested from other agencies;
- Actions discussed in current river management plans; and
- Management issues identified by various organizations and the general public during the scoping meetings conducted on October 5, 1999 in Las Cruces, New Mexico and October 6, 1999 in El Paso, Texas. Comments received dealt primarily with land use and biological resources issues, particularly vegetation, and to a lesser extent with water resources, recreation, and geology and soils. Table 4.1 presents a summary of management issues identified during the scoping meetings.

Two technical workshops were held at the USIBWC offices in El Paso on September 12 and 13, 2000 to review the matrix of alternatives and incorporate input from regulatory agencies and the irrigation districts into the alternatives formulation process. A subsequent public workshop was held in Las Cruces on October 12, 2000 to obtain further public input for the alternatives formulation.

4.2.2 Rearrangement and Consolidation of Actions

Alternatives were formulated as a combination of multiple actions. To facilitate the formulation, the list of potential actions was reorganized into eight categories: 1) modifications to current operation and maintenance practices; 2) structural actions for flood control capabilities; 3) in-channel habitat enhancements; 4) floodway habitat enhancements; 5) habitat enhancements adjacent to the floodway; 6) actions associated with watershed management; 7) flow regime modification; and 8) other actions. Potential actions are described in Appendix B. Current practices are described in Section 3.2.

Table 4.1 Summary of Management Issues Identified During Public Scoping.

Resource Area	Issue
Biological Resources	• Remove salt cedar and other invasive species; replace/enhance native vegetation • Riparian habitat restoration - cottonwood plantings, willow/native forested strip along the river • Promote environmental protection and enhancement; monitor and promote improvements in overall ecosystem health • Modify grade control structures to be less harmful to fish • Prepare a Fish & Wildlife Coordination Report for the proposed action • Consider the potential effects to state and federal listed species • Establish in-stream flows to promote wildlife habitat
Cultural resources	• Consider the potential effects to cultural resources
Soils	• Watershed management to reduce erosion damage • Control erosion through vegetative rather than structural means
Land Use	• Widening the existing levees/floodplain could be incompatible with or encroach on existing uses • Change emphasis from flood control to floodplain management (multiple purpose, flexible, and adaptive management scenarios, non-structural emphasis) - operation and maintenance practices (mowing, burning, livestock management) • Target arroyo mouths for channel and riparian improvements • Promote seasonal overbank flooding to restore historic habitat and fluvial processes • Protect vulnerable capital improvements, cropland, and human populations • Expand the width of the floodplain to manage floodwaters and sediment, promote meandering, and provide space for habitat improvement; acquire adjacent property to promote widening (move back or selectively breach levees; compatible joint use in adjacent lands) • Revise and establish appropriate design flood/recurrence interval targets; institute floodplain zoning or stop development in the flood zone • Re-establish wetlands systems along the river for water quality, flood control, and habitat benefits
Recreation	• Improve access to users during recreation/hunting seasons; restrict access for detrimental practices • Expand recreational opportunities, including planned Rio Grande Trail Park; promote educational opportunities associated with project facilities and habitat restoration • Management changes will affect recreation opportunities

Resource Area	Issue
SOCIOECONOMIC	• Changes in management approaches could result in adverse socioeconomic effects in local communities, including inability to supply projected demands for water
TRANSPORTATION	• Changes in river management approaches could affect transportation facilities in the affected area
WATER RESOURCES	• Management changes in river/floodplain management will result in loss of water rights and water availability from vested rights holders • Management changes could affect water quality and quantity in the river and in local ground water • Simulate natural hydrologic cycle of flows • Promote more efficient water usage and water conservation • Improve water delivery capability through canalization of the entire river • Promote conjunctive use of water resources in the project area • Define and promote conformance with water quality objectives throughout the project area
NO ACTION	• Continue historical operations and maintenance practices, maintain current flood control status

4.2.3 Preliminary Matrix of Alternatives

Table 4.2 presents a matrix of alternatives developed on the basis of the reorganized list of potential environmental actions, as well as engineering judgment and experience. The matrix is composed of five basic alternatives that reflect a gradual decrease in flood control capabilities with existing flood control measures and a general increase in potential habitat enhancements (Table 4.3). Three of those basic alternatives were further divided to form a total of nine sub-alternatives as follows:

1. *No action*. Continue existing operation and maintenance practices to maintain flood protection and provide for water deliveries, and maintain three no-mow zones and 13 mitigation sites.
2. *Maintain flood protection and water deliveries in combination with habitat enhancements.* Undertake various actions for enhancements and compensate for changes in flood hydraulics by modifying or upgrading flood control systems.
    a. *Floodway within the levees*. Increased vegetation in the floodway and in-channel modifications with upgrades to flood protection systems to compensate for changes in flood hydraulics;
    b. *Areas adjacent to floodway*. Changes in irrigation canal maintenance procedures or property acquisition in coordination with future projects (e.g. construction of water treatment plants as part of the El Paso-Las Cruces Regional Sustainable Water Project); and
    c. *Maximize the number of actions and locations*. Placement of enhancements both inside and outside levees (combination of options 2a. and 2b.).

3. *Habitat enhancements with a partial reduction in current maintenance activities.* Habitat enhancement actions are implemented with operation and maintenance reduction, with possible decrease in current flood control capacity for some areas.
   a. Selected actions and locations of habitat enhancements inside and outside levees; and
   b. Maximum number of actions and location of habitat enhancements.
4. *Limiting maintenance practices to the levees.* Eliminate most operation and maintenance or perform minimal maintenance on levees. Possible actions include planting of vegetation, installation of structures to create habitat, and allowing sediment to accumulate within the river channel. May not maintain current level of flood protection in some areas.
   a. Without enhancements. No additional habitat enhancements but maintenance of 13 mitigation sites and three green zones; and
   4. With enhancements. With additional habitat enhancements inside and outside levees.
5. *Decommission***.** Eliminate all operation and maintenance or perform minimal maintenance on levees. Allow vegetation to develop and sediment to accumulate within the river channel. Current level of flood protection is not likely to be maintained.

4.3 Initial Screening

4.3.1 General Screening Criteria

Preliminary alternatives were evaluated using 13 general evaluation criteria that were grouped in the categories of project functionality, potential for environmental enhancements, and feasibility of the alternative. Those criteria are the following:

Project Functionality

- Flood control protection;
- Maintain water delivery;
- Reduce sediment load to river; and
- Reduce erosion of riverbanks.

Potential for Environmental Enhancements

- Restore, maintain, or improve native riparian habitat;
- Restore, maintain, or improve aquatic habitat;
- Restore natural fluvial processes;

Table 4.2 Preliminary Matrix of Alternatives

	ALTERNATIVES								
	1	2A	2B	2C	3A	3B	4A	4B	5
	No Action	Flood Protection/Water Delivery + Habitat Enhancements			Reduced O&M + Habitat Enhancements		Maintenance Limited to the Levees		Decom-mission
Actions to be implemented:	Continue Current O&M	Floodway Within the Levees	Areas Adjascent to Floodway	Selected No. of Actions & Locations	Selected Actions & Locations	Maximize No. of Actions & Locations	Without Enhance-ments	With Enhance-ments	No Further O&M
REDUCE/ELIMINATE CURRENT O&M PRACTICES									
Patrol and inspect project and operations									X
Levee maintainance									X
Bank stabilization							X	X	X
Construction of river training works							X	X	X
Maintainance of structures on wasteways/drains							X	X	X
Maintainance of NRCS dam structures							X	X	X
Vegetation control in the floodway					X	X	X	X	X
Dead tree snags removal					X	X	X	X	X
Sediment removal by dredging					X	X	X	X	X
Maintenance of stockpile sites, fill and spoil areas, haul roads					X	X	X	X	X
Maintainance of existing fish habitat structures							X		X
Maintainance of existing green areas and planting sites							X	X	X
IMPROVE FLOOD CONTROL CAPABILITIES									
Raise levees		X	X	X	X	X			
Rehabilitate, widen or strengthen levees		X	X	X	X	X		X	
Setback levees to dissipate floods in the floodway			X	X	X	X	X	X	
Reduce runoff entering river during flood			X	X	X	X			
Purchase flood easements			X	X	X	X			
Install/modify grade control structures to prevent scour		X		X	X	X			
Revise design flood		X	X	X	X	X		X	
IN-CHANNEL HABITAT ENHANCEMENTS									
Widen low-flow channel		X		X	X	X			
Install additional rock groins for fish habitat		X		X	X	X			
Modify water diversion features for fish habitat		X		X		X			
Modify drain/spillway river confluence		X		X	X	X			
Widen channel to create embayments, backwaters and sloughs		X		X	X	X			
Modify channel maintenance at arroyos for fish habitat		X		X	X	X			
Increase sinuosity of river, create meanders						X			X
Create split channels		X		X	X	X			
Modify dams for fish passage				X		X			
Instream habitat enhancements at existing dams				X	X	X			
Add woody debris for fish habitat						X			
FLOODWAY HABITAT ENHANCEMENTS									
Remove grazing of livestock					X	X	X	X	X
Plant native riparian vegetation					X	X		X	X
Remove invasive vegetation/fauna (Tamarisik, cowbirds)					X	X		X	
Establish additional green zones					X	X	X	X	X
Purchase land/development rights to preserve open space			X	X	X	X			
Stop or reduce mowing						X	X	X	X
HABITAT ENHANCEMENTS ADJACENT TO FLOODWAY									
Develop flood retention areas			X	X	X	X			
Establish wetlands in old oxbows			X	X	X	X			
Partial breaching of levees for occasional flooding			X	X	X	X			
Purchase conservation easements for habitat			X	X	X	X			
Construct treatment wetlands for drains into rivers			X	X	X	X			
Reduce canal drain maintenance to one side only			X	X		X			
WATERSHED MANAGEMENT									
Install bank stabilization for additional erosion control		X		X	X	X			
Purchase conservation easements for erosion control			X	X	X	X			
Establish/enforce erosion control practices & regulations			X	X		X			
Install additional erosion control blankets		X		X					

Table 4.2 Preliminary Matrix of Alternatives

	ALTERNATIVES								
	1	2A	2B	2C	3A	3B	4A	4B	5
	No Action	Flood Protection/Water Delivery + Habitat Enhancements			Reduced O&M + Habitat Enhancements		Maintenance Limited to the Levees		Decom-mission
Actions to be implemented:	Continue Current O&M	Floodway Within the Levees	Areas Adjascent to Floodway	Selected No. of Actions & Locations	Selected Actions & Locations	Maximize No. of Actions & Locations	Without Enhance-ments	With Enhance-ments	No Further O&M
WATERSHED MANAGEMENT (Cont.)									
Install sediment retention dams on arroyos			X	X		X			
Remove populations/infrastructure from floodplain				X				X	X
Incorporate flood protection in land planning			X	X				X	X
Stop development in flood zone			X	X				X	X
Implement water conservation practices			X	X					
Retire farmlands						X	X		X
FLOW REGIME MODIFICATION									
Establish in-stream flows for each segment		X		X		X			
Modify flow regime to a more natural function		X		X		X			X
Obtain water rights for flow control		X		X					
Year-round in-stream flows		X		X		X			X
Remove levees									X
Allow floods to dissipate on flood plain									X
Promote overbank (over low-flow channel) flooding						X			
Move sediment by controlled flow surges		X		X					X
OTHER ACTIONS									
Enhance aquifer recharge during wet years			X	X					
Water conservation				X					
Control of non-point source pollution				X					
Use future WTP reservoirs for habitat development			X	X					
Configure storm water ponds as bird habitat			X	X					
Improve water quality (nutrient loading, temperature)			X	X					
Monitoring of enhancements				X					
Multi-agency cooperation for river management				X					
Create recreational facilities; picnic areas, paths.		X		X					
Improve access/create alternative transportation routes		X		X					

Note: off-channel refers to outside levees;
Floodway refers to inside levees but above normal river water level

Table 4.3 Trends for Flood Control and Environmental Enhancement

	ALTERNATIVES								
	1	2A	2B	2C	3A	3B	4A	4B	5
	No Action	Flood Protection/Water Delivery + Habitat Enhancements			Reduced O&M + Habitat Enhancements		Maintenance Limited to the Levees		Decom-mission
Actions to be implemented	Continue Current O&M	Floodway Within the Levees	Areas Adjascent to Floodway	Selected No. of Actions & Locations	Selected Actions & Locations	Maximize No. of Actions & Locations	Without Enhance-ments	With Enhance-ments	No Further O&M
CURRENT PRACTICES	Maintain	Maintain	Maintain	Maintain	Reduce	Reduce	Minimize	Minimize	Discontinue
ADDITIONAL PRACTICES									
Improve flood control capabilities		Some	Multiple	Multiple	Multiple	Multiple	Some	Some	
In-channel habitat enhancements		Multiple		Multiple	Some	Multiple		Some	Some
Floodway habitat enhancements					Some	Multiple	Some	Multiple	Multiple
Habitat enhancements adjacent to floodway			Multiple	Multiple	Multiple	Multiple		Some	
Watershed management		Some	Multiple	Multiple	Some	Multiple	Multiple	Multiple	Multiple
Flow regime modification		Multiple		Multiple		Some	Some	Some	Multiple
Other actions		Some	Multiple	Multiple					

DECREASING FLOOD CONTROL --------------->
INCREASING HABITAT ENHANCEMENT ------>

- Provide connection to uplands and other eco-regions; and
- Promote activities adjacent to the river.

Feasibility of the Alternative

- Construction cost;
- Operation and maintenance cost;
- Need for land acquisition; and
- Need for water rights.

4.3.2 Screening of Alternatives

A scoring system was developed for screening of alternatives based on the 13 criteria previously listed. The scoring system was applied to each alternative individually. The scoring was based on the subjective assignment of a positive value to actions that were likely to be beneficial in terms of a given criterion, and a negative value to those actions with a potential adverse effect relative to current conditions. All actions within an alternative received subjective values of +1, 0, or –1 for each of the 13 criteria.

Table 4.4 summarizes the combined scores applicable to each of the 13 screening criteria for each of the 9 alternatives. Cumulative scores were also calculated for the main objectives of project functionality, potential for environmental enhancements, and feasibility of the alternative. Overall, Alternatives 4a, 4b, and 5 have very low cumulative scores in terms of project functionality. Alternatives 2a, 2b, 2c, 3a, and 3b showed low scores for feasibility indicating relatively high costs of implementation relative to the other alternatives. Scoring of the alternatives resulted in the following:

1. Alternative 1 (No-action Alternative) reflects current operation and maintenance practices and is retained for further evaluation as a reference for the other proposed alternatives.
2. Preliminary Alternatives 2a, 2b, and 2c combined current operation and maintenance practices with various types of environmental enhancements. Individually, these three alternatives were considered economically and operationally unrealistic, and thus fatally flawed. For subsequent analyses, a revised Alternative 2 was developed that limited enhancements to those within the floodway (as in Alternative 2a) and, unlike Alternative 2c, also limited the number of potential actions and locations.
3. Preliminary Alternatives 3a and 3b include actions considered under Alternative 2 as well as elimination or reduction of some operation and maintenance practices to obtain environmental enhancements. Only Alternative 3a, which considers a limited number of actions and locations, was retained for further analysis as revised Alternative 3.

4. Preliminary Alternatives 4a and 4b entailed reduction or elimination of additional operation and maintenance practices, such as construction of river training works, to promote river restoration. Similarly, preliminary Alternative 5 considered total decommissioning of the Project to allow the river system to return to a fully natural state. These three alternatives were discarded as fatally flawed, as they would prevent USIBWC from fulfilling its obligations of ensuring water delivery and flood control protection.
5. A new Alternative 4 was developed to reflect river restoration activities. This new alternative combines habitat enhancement attributes of Alternative 3 with actions leading to partial river restoration.
6. A new Alternative 5 was also developed to include watershed-oriented river management activities beyond the stated objectives of the Project.

4.3.3 Revised Matrix of Alternatives

A matrix of five revised alternatives was retained for further analyses. The sequence of revised alternatives, from Alternative 1 to Alternative 5, represent an increase in environmental enhancements and restoration activities as well as significant increases in implementation costs. Table 4.5 lists actions associated with each alternative. The main features of the revised alternatives are listed below.

Alternative 1, Maintain Current Operation. Current operation and maintenance practices are maintained in terms of:

- Sediment dredging and disposal;
- Vegetation control in the floodway and land leases; and
- Maintenance of no-mow zones and existing aquatic habitat structures.

Alternative 2: *Modification of Operation and Maintenance*. Includes Alternative 1 actions and the following:

- Additional aquatic habitat structures at current mitigation sites;
- Construction of flood control levees;
- Expand no-mow zones and minimize sediment dredging; and
- Implementation of erosion control at siphons.

Alternative 3: Integrated USIBWC Land Management. Includes Alternative 1 and 2 actions and the following:

- Additional aquatic habitat structures at new mitigation sites;
- Additional wetland, riparian, and terrestrial habitat at multiple sites;
- Modification of spoil disposal practices; and
- Discontinuation of most grazing leases.

Table 4.4 Summary of Scoring of Alternatives by Criteria

	CUMULATIVE SCORE BY CATEGORY			PROJECT FUNCTIONALITY				ENVIRONMENTAL ENHANCEMENTS					FEASIBILITY			
	Functi-onality	**Envir. Enhance-ment**	**Feasi-bility**	Flood control protection	Water delivery	Sediment load to river	Erosion of river banks	Native riparian habitat	Native aquatic habitat	Restoration of other natural fluvial processes	Connection to uplands and other eco-regions	Activities adjacent to river	Construc-tion Cost	O&M Cost	Need for land acquisition	Need for water rights acquisition
Alternative 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alternative 2A	-1	22	-27	-1	0	1	-1	4	11	3	0	4	-11	-11	-2	-3
Alternative 2B	22	31	-33	8	3	8	3	10	7	4	5	5	-12	-8	-10	-3
Alternative 2C	20	60	-63	6	2	10	2	15	21	8	6	10	-23	-22	-12	-6
Alternative 3A	5	46	-42	0	0	4	1	11	15	5	8	7	-16	-13	-9	-4
Alternative 3B	-3	65	-57	-3	-4	4	0	17	23	8	9	8	-21	-16	-11	-9
Alternative 4A	-19	11	10	-9	-2	-5	-3	3	2	2	3	1	1	12	0	-3
Alternative 4B	-7	22	-6	-2	-1	-2	-2	8	5	3	4	2	-5	6	-3	-4
Alternative 5	-34	26	-7	-12	-8	-6	-8	10	6	6	5	-1	-4	10	-4	-9
Minimum value	-34	0	-63	-12	-8	-6	-8	0	0	0	0	-1	-23	-22	-12	-9
Maximum value	22	65	10	8	3	10	3	17	23	8	9	10	1	12	0	0

Table 4.5 Revised Matrix of Alternatives

PROPOSED ACTIONS	ALTERNATIVES				
	1	2	3	4	5
	Operation (No Action)	Selective O&M Modification	Integrated IBWC Land Management	Targeted River Restoration	Multipurpose Watershed Management
STRUCTURAL ACTIONS FOR FLOOD CONTROL					
Raise levees		X	X	X	X
Rehabilitate, widen or strengthen levees		X	X	X	X
Setback levees to dissipate floods in the floodway			X	X	X
Reduce runoff entering river during flood					X
Install/modify grade control structures to prevent scour		X	X	X	X
AQUATIC HABITAT ENHANCEMENTS					
Widen low-flow channel			X	X	X
Install additional rock groins for fish habitat		X	X	X	X
Modify water diversion features for fish habitat			X	X	X
Modify drain/spillway river confluence		X	X	X	X
Create embayments, backwaters and sloughs		X	X	X	X
Modify channel maintenance at arroyos for fish habitat			X	X	X
Create split channels			X	X	X
Modify dams for fish passage					X
Add woody debris for fish habitat				X	X
Reduce/eliminate sediment removal by dredging					X
RIPARIAN HABITAT ENHANCEMENTS					
Modify or reduce grazing of livestock		X	X	X	X
Plant native riparian vegetation		X	X	X	X
Remove invasive vegetation/fauna (Tamarisik, cowbirds)			X	X	X
Establish additional green zones (no mow)		X	X	X	X
Purchase land/development rights adjacent to the floodway				X	X
Reduce mowing frequency/coverage		X	X	X	X
Reduce canal drain maintenance		X	X	X	X
RESTORATION OF FLUVIAL PROCESSES					
Develop flood retention areas				X	X
Increase sinuosity of river, create meanders or oxbows			X	X	X
Obtain flood easements and modify levee design for occasional flooding				X	X
Purchase conservation easements for habitat				X	X
Establish in-stream flows for each segment				X	X
Modify flow regime to a more natural function (including overbank flooding)				X	X
Significant levee removal to allow flood to dissipate on flood plain					X
Perform point bar shave-downs to promote overbank (over low flow channel) flooding			X	X	X
MULTI-PURPOSE MANAGEMENT					
EROSION CONTROL IN TRIBUTARY BASINS					
Install bank stabilization for additional erosion control					X
Purchase conservation easements for erosion control					X
Establish/enforce erosion control practices & regulations					X
Install additional erosion control blankets					X
Install sediment retention dams on arroyos					X
NON-STRUCTURAL FLOOD CONTROL ACTIONS					
Incorporate flood protection in land planning					X
Stop development in flood zone					X
Purchase flood easements					X
Revise design flood					X
Retire farmlands adjacent to floodway					X
WATER CONSERVATION/QUALITY IMPROVEMENT					
Implement water conservation practices					X
Improve water quality (reduced nutrient loading, temperature)					X
Control of non-point source pollution					X
USE OF MAN-MADE STRUCTURES					
Use future WTP reservoirs for habitat development (uplands)					X
Configure storm water ponds as bird habitat (uplands)					X
Create additional recreational facilities; picnic areas, paths.					X

Alternative 4: Targeted Stream Restoration. Includes Alternatives 1, 2, and 3 actions and the following:

- Acquisition of flood easements and property for levee setbacks;
- Tree planting outside right-of-way; and
- Re-creation of river meanders outside right-of-way.

Alternative 5: Multipurpose Watershed Management. Includes Alternatives 1, 2, 3 and 4 actions and the following:

- Sediment control in sub-basins;
- Backwater habitat at dams;
- Water quality improvement;
- Recreation areas; and
- Peak flows and minimum instream flows.

SECTION 5

DEVELOPING ENVIRONMENTAL CRITERIA AND MEASURES

5.1 River Restoration and Enhancement Approach

The approach to river restoration and enhancement is incremental. Environmental actions are those passive or active project or maintenance activities that would be considered for environmental restoration, enhancement, creation, or rehabilitation on the river. The process developed for the Project broadly follows recommendations described in the document *Stream Corridor Restoration, Principles Processes and Practices* (USEPA 1998). The recommendations have been modified and generally applied to the Project's river restoration and enhancement approach. The approach to restoration and enhancement (environmental actions) follows five basic steps:

1. **Describe baseline conditions and assess causes of degradation.** Riparian ecosystems across the southwest are declining due to anthropogenic disturbances. Degradation is a result of direct impacts as well as the cumulative effect of numerous, indirect impacts. Baseline conditions for the Project were discussed in Section 3.4, as well as causes of environmental degradation such as:
   - Hydrologic modifications;
   - Dam construction;
   - Canalization and river straightening;
   - Floodplain reduction;
   - Sediment reduction;
   - Land use changes; and
   - Invasive species.
2. **Determine potential for restoration**. Understanding the potential for restoration and enhancement of the Project areas requires an understanding of the historical conditions that existed in the Project area prior to degradation and what future conditions might be. The extent and magnitude of changes in the Project's watershed will constrain the restoration and enhancement potential for many sites.
3. **Develop clear, achievable, and measurable goals as the basis for defining restoration and enhancement actions.** Articulating goals is a prerequisite for defining a defensible set of actions within myriad possibilities presented by the Project. The goals are ecologically based but couched within Project mission requirements and feasibility of implementation. Environmental goals determine which environmental actions are implemented as well as the locations of actions (sites).

4. **Develop environmental measures.** The measure for evaluating environmental actions and environmental goal achievement is based on types of habitat produced.
5. **Design, implement, and monitor environmental actions.** Some environmental actions will require detailed engineering design to ensure the desired result. Following implementaion, the environmental actions should be closely studied to evaluate their success or failure.

Overall, environmental actions should attempt to reestablish the ecological integrity of the system. Ecological integrity refers to the condition of an ecosystem, particularly the structure, composition, and natural processes of its biotic communities and physical environment.

Structure and function are closely linked. Reestablishing the appropriate natural structure can bring back beneficial functions. In order to maximize the ecological benefits of environmental actions, it is essential to identify what riparian functions are absent in the Project and develop corrective actions that address missing or impaired functions.

5.1.1 Terminology and Concepts

Restoration and enhancement are often used synonymously, blurring the distinction between potentially different processes. The processes can fundamentally impact the type of actions proposed for managing the Project. The definitions are intended to clarify terminology and are used for subsequent identification of goals (environmental) and for developing a measure for evaluating environmental actions. The environmental goals are based on the following terms and used for identifying specific actions associated with each alternative.

Restoration

Restoration is reestablishment of the structure and function of ecosystems to return the system as closely as possible to predisturbance conditions (National Research Council 1992). Implicit in this definition is that ecosystems are naturally dynamic and it is not possible to recreate a system exactly. The restoration process reestablishes the general structure, function, and dynamic but self-sustaining behavior of the ecosystem. The objective is to emulate a natural, self-regulating system that is integrated ecologically within the landscape in which it occurs. Restoration requires manipulation of physical, chemical, or biological characteristics of the system to return an ecosystem to a close approximation of its condition prior to disturbance (Lewis 1989).

Enhancement

Enhancement is the manipulation of the physical, chemical, or biological characteristics of a system, which heighten, intensify, or improve specific functions. Examples include improving water quality, flood water retention, or wildlife habitat.

Enhancement can result in a change of function and can even lead to a decline in other functions. This term includes activities commonly associated with the terms, management, manipulation, and directed alteration.

Rehabilitation

Rehabilitation is making the land useful again after a disturbance. Rehabilitation does not necessarily reestablish the predisturbance condition, but does involve establishing geological and hydrologically stable landscapes that support the natural ecosystem mosaic.

Reclamation

Reclamation is a series of activities intended to change the biophysical capacity of an ecosystem. The term implies the process of adapting wild or natural resources to serve a utilitarian human purpose such as conversion of riparian or wetland ecosystems to agricultural, industrial, or urban uses.

Restoration differs from rehabilitation and reclamation in that restoration is a holistic process not achieved through isolated manipulation of individual elements. While restoration aims to return an ecosystem to a former natural condition, rehabilitation and reclamation imply putting a landscape to a new or altered use to serve a particular human purpose (National Research Council 1992).

Creation

Creation is the construction of a habitat (riparian, wetland aquatic, etc.) in an area that was not that particular habitat in the recent past (Gwin, *et al*. 1999). Creation occurs when habitat is placed on the landscape by some human activity on a site not exhibiting the newly created habitat characteristics (Lewis 1989). Wetland creation is common example of habitat creation and typically developed by excavation of upland soils to elevations that will support the growth of wetland species through establishment of an appropriate hydrology.

Mitigation

Mitigation, a term that frequently occurs in discussions of restoration, refers to the restoration, creation, or enhancement of features to compensate for destruction of existing habitat. Mitigation typically is for making restitution for some action. In the case of wetlands, under Section 404 of the Clean Water Act, wetlands may legally be destroyed, but their loss must be compensated for by the restoration, creation, or enhancement of other wetlands. In theory, this strategy should result in “no net loss.”

Mitigation can broadly refer to other categories of environmental actions. For example, avoidance of high quality or important resources during construction projects and acquisition of important or high quality resources for protection may be considered mitigation. Short-term measures used to control construction impacts such as dust control and erosion protection are also referred to as mitigation.

5.1.2 Functions of Riparian Systems

Riparian systems are generally defined as land occurring along a water body (Briggs 1996). A slightly different definition is used by the Bureau of Land Management (BLM), which defines riparian areas as a form of wetland transition between permanently saturated wetlands and upland areas with interaction of three components: 1) vegetation, 2) landform/soils, and 3) hydrology. Fish and wildlife are sometimes regarded as the fourth element because some wildlife may alter a riparian area's capability and potential. Riparian areas provide numerous environmental functions that include (Briggs 1996):

1. Transition zones between different ecosystems, (e.g., desert scrub and aquatic) creating high biotic density and diversity.
2. Stream bank stabilization from vegetation cover and root mass.
3. Wildlife corridors.
4. Wildlife and fisheries habitat.
5. Threatened and endangered species habitat.
6. Sediment traps, runoff filtration, and nutrient sinks.
7. Moderation of water temperature (e.g., by shading).
8. Groundwater recharge and flood hazard reduction.
9. Stream buffers.
10. Increased productivity over surrounding terrestrial communities due to the availability of water and nutrients. Vegetation is generally taller and denser, providing a large food base and cover for wildlife.

The distinction between riparian and aquatic systems when discussing restoration at the Project level is problematic. The relationship between riparian and aquatic systems is inseparable, and by definition, without the aquatic influence, a riparian system would not be defined as such. As a result, discussions concerning riparian areas implicitly include the aquatic system as well. When functions are identified for the riparian system, aquatic system functions are embedded within it. Distinction between aquatic and riparian are clearly made when identifying environmental actions, classifying land cover and developing measures; however, for the purpose of system functions they are combined.

The functioning condition of a riparian system is a result of the interaction of geology, soils, water, and vegetation. A naturally functioning riparian system contains adequate vegetation or woody debris cover and/or root mass to reduce soil erosion and protect water quality by filtering sediment. In addition, characteristics of a natural system include an active floodplain with diverse channel characteristics to provide varied aquatic habitat for fish production, waterfowl breeding, and other wildlife uses. These channel characteristics are formed by periodic flooding and high velocity flows, which may be accompanied by some erosion, bank scouring, and local loss of vegetation.

Figure 5.1 illustrates typical cross-sections of the successional development of a riparian system. Most attributes of a properly functioning riparian system, as defined by BLM, would typically be present in the later seral stages of development. As shown in Figure 5.1, the later seral stages illustrate a stream channel bank stabilized by mature vegetation cover and significant root mass. These features serve to reduce erosion potential and sediment loading. A variety of plant species is typically present which provide food and cover for wildlife, including the presence of dead woody plants (snags). Research on southwestern riparian systems similar to the pre-disturbance Canalization Project found that riparian areas supported a large diversity of wildlife (Farley *et al.* 1994, Engel-Wilson and Ohmart 1978, Bock and Bock 1990) particularly neo-tropical migratory birds (Ellis 1995).

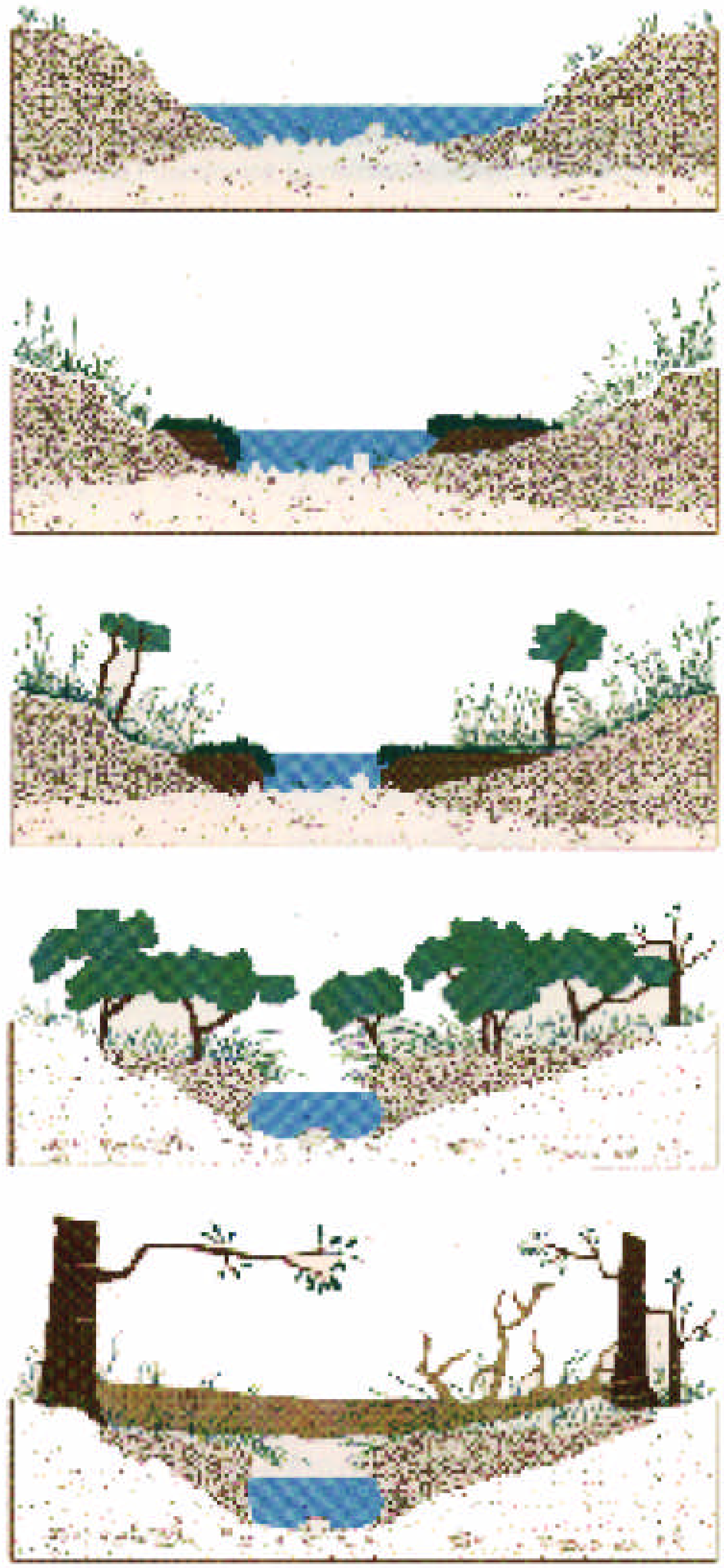
5.2 Potential for Restoration and Enhancement

Selection of environmental actions for restoration should encourage recovery of as many natural processes as possible by removing as many stressors (causes of degradation) as possible. The greater the number of stressors that can be removed, the greater the potential for successful restoration of a riparian ecosystem (Patten 1999).

Restoration can be passive or active. Actions such as peak flows, expansion of no-mow areas, and discontinuation of grazing leases are examples of passive restoration approaches (Patten 1999). Revegetation, mechanical shaping of the channel margin, and removal of exotic species are active restoration approaches. Given the magnitude of the Rio Grande floodplain transformation, approaching complete restoration of the Canalization Project ecosystem is unrealistic; however, potential exists for many areas where system functionality can be restored and/or enhanced.

5.2.1 Restoration and Enhancement Within Context of the USIBWC Mission

There are inherent conflicts between a fundamental requirement in the river restoration and enhancement approach (e.g. address causes of degradation) and what can realistically be implemented within the project jurisdiction. As a result, environmental enhancement actions are fully considered within the context of the mission rather than giving equal consideration to the entire watershed. While not ideal from a purely environmental viewpoint, it is realistic. Environmental actions addressing impacts associated with the Project mission activities are more readily addressed than the impacts due to changes within the Project watershed caused by other processes (dams construction, hydro period changes, agriculture, urbanization, etc). As discussed in the section referring to causes of degradation, Project activities related to mission requirements are but a subset of the many impacts influencing the current condition of the river.



A
Bare Ground

B
Early Seral

C
Mid Seral

D
Late Seral

E
PNC or PPC*

Source: BLM Technical Reference 1737-9, 1993.

* (PNC) Potential Natural Community,
(PPC) Potential Plant Community

Figure 5.1

Typical Cross Sections of the Successional Development of a Riparian System

Parsons Engineering Science, Inc.

It should be made clear that the watershed context is considered throughout the alternatives formulation process, but Project mission activities and requirements are emphasized. The development of environmental goals considers degradation causes to assure that environmental goals and subsequent actions are feasible and include actions outside of the Project jurisdiction (Alternatives 4 and 5) when possible.

A primary tool for determining feasibility of environmental actions is the hydraulic model, HEC-RAS. The modeling process involves comparing current flooding potential with flooding potential of the river after environmental restoration and enhancements are implemented. There were significant discussions on how flood control requirements should influence potential environmental actions. Whether or not flood prone areas would limit environmental actions or whether flood prone areas provided opportunities for additional environmental actions was explored.

Mission priorities would override environmental actions if such action aggravated flooding conditions based on HEC-RAS model results. However, environmental actions can reasonably occur in conjunction with flood control improvements such as raising levees or levee setbacks if analyses reveal that costs associated with protecting sites from flooding exceeds benefits. Examples include allowing flooding of croplands or undeveloped sites outside of the right-of-way rather than incurring costs of levee maintenance or upgrade. Formulation of goals considers Project mission requirements first then evaluates the feasibility of success based on restoration and enhancement potential.

5.2.2 Related Restoration Actions in Arid Environments

Riparian restoration has been conducted in similar environments to that of the Project area. Restoration and enhancement for portions of the Project area has potential and, as evidenced by a sample of regional projects, is possible. The magnitude of regional or other restoration projects is considerably less than the suite of alternatives analyzed for the Canalization Project; however the underlining theme to derive from such a review is that momentum for such projects are increasing in the southwest. The success of restoration is demonstrated by the following examples of restoration projects in the southwest.

<u>Sheepshead Spring: Focusing on the Uplands before the Bottomlands</u>

Sheepshead Spring is a small, perennial stream in the Coconino National forest near Cornville, Arizona. Much of the channel bed had eroded to bedrock, and streamside vegetation consisted of annual grasses. Revegetation was not performed. Instead, livestock were excluded from the bottomlands, and improved livestock management schemes on the uplands were implemented. In addition, two check dams were constructed across the width of the channel to promote alluvial deposition. Vegetation regeneration 8 years after the completion of work was considerable.

Aravaipa Creek: Natural Recovery after Flooding

Aravaipa Creek flows through Aravaipa Canyon, draining portions of the Galiuros and Pinaleño Mountains in southwestern Arizona. In 1983, a 500-year flood passed through the canyon removing significant amounts of streamside vegetation. To encourage the recovery of Aravaipa's riparian communities, a large revegetation project was completed after this flood event. More than 2,000 native plants were planted. At the time of the site evaluation 7 years after flood damage occurred, natural regrowth was so extensive that results of the artificial revegetation effort could not be found.

City of Albuquerque Overbank Project (Reclamation 2000)

The Albuquerque Overbank Project site is located on the southern end of an elevated alternate river bar on the west side of the Rio Grande, north of Rio Bravo. Due to river bed degradation, it has received little if any overbank flooding in recent decades. This collaborative project was designed to evaluate the effectiveness of bank clearing and lowering to reestablish native woody vegetation (cottonwoods and willows) on such a site in the Albuquerque Reach. It involved clearing and root plowing the bar's dense Russian olive cover, then lowering part of the bar to allow for flooding during spring runoff events and summer wet periods. Of four cleared acres, 2.4 acres adjacent to the riverbank were lowered by approximately 2 feet. Eight thousand cubic yards of removed material were spread over a connected (lower) sandbar south of the cleared site, and then blended. Shallow channels and topographic undulations were created on the cleared bar to facilitate floodwater distribution leading to the establishment of native tree seedlings.

The site flooded in May and June, 1998. Flooding occurred at flows over approximately 2,500 cfs. In 1999 there were three overbank inundations: in late May-early June, late June, and early August. Relatively elevated parts of the site did not flood, even at flows approaching 5,000 cfs. Prior to restoration activities, the river channel adjacent to the site had uniform depth, velocity, and width for variable discharges. However, because of extensive erosional changes in the bank profile and change in site topography, the river channel is now much more variable in depth, width, and velocity for variable discharges. Over 8,000 cottonwood seedlings, and smaller numbers of coyote willow, salt cedar, and Russian olive, were established during the first flood season. Most of the cottonwoods died before the second season, but the remaining patches are conspicuous in places (some are 6-7 feet in height) and account for more cover than do survivors of the other woody species.

Santa Ana River Rectification Project (Santa Ana 1999)

The Santa Ana River Rectification Project encompasses approximately 6,500 feet of the Rio Grande. The project consists of three phases being constructed over a 3 to 5 year period. Phase 1, which will occur during the first year, will consist of the installation of a gradient restoration facility (GRF) and accompanying fish passage apron, the excavation of a 25-foot pilot channel, installation of river dikes to block off the existing river channel, and excavation of trenches along the estimated bankline position to install bioengineering. A cofferdam will be established around the GRF construction. A sheet pile wall may be placed between the active river channel and the bioengineering trenches to allow planting and a 6-inch stone toe placement. Dewatering will occur at both activities.

The bankline bioengineering will consist of planting willows along the bankline and toe protection of 6-inch rock along the toe of the bank. The rock is wrapped in biodegradable coir fabric. The coir fabric will keep the rock in place until vegetation is established on the bankline. The rock is sized such that it will move during a 5-year flood event. The bankline will also have rootballs and footer logs installed.

The widening of the river may take longer than 1 year, depending on the year's runoff. Excavation of some of the floodplain will also occur during this phase. Phase 2 will begin after the pilot channel has widened into the new river channel. This phase will consist of excavating the remaining floodplain areas, the planting of these areas and installation of bendway weirs. Bendway weirs are low-level, upstream-angled stone sills attached and keyed to the outer bank of a bend. The weirs are angled from 5 to 25 degrees upstream, with a height of 2 feet in the stream and 4 feet at the bank (USACE 2001). The bendway weirs may be constructed in Phase 3 if the channel is continuing to adjust to the new alignment during Phase 2. Phase 3 will consist of the installation of the second GRF and revegetation efforts. It should be noted that the second GRF installation is dependent upon funding from other sources. Below are the specifics of each phase.

5.2.3 Work Within a Watershed Context

The watershed context is an approach that considers impacts and benefits within a watershed whether or not a specific environmental action encompasses the watershed scale. The actions defined within the alternatives, independent of alternatives (i.e. within or outside of USIBWC lands) must be designed and implemented with consideration of watershed impacts. Alternatives define "what" actions can be accomplished; the watershed context determines "how" actions are implemented.

Restoration and enhancement within a watershed context takes into consideration the uplands, upstream and downstream of reaches, and tributaries. This is important because the structure and process of ecosystems are determined by their connection with adjacent ecosystems (Briggs, 1996). Environmental actions may not be able to change what goes on in the whole watershed, but it can be designed to better accommodate watershed effects. By considering the watershed context, environmental actions can be designed to remediate the effects of adjacent land uses and consider factors such as interactions with terrestrial habitats in adjacent watersheds. The concept of considering the watershed context can apply to several of the identified alternatives, not only Alternative 5.

5.3 Environmental Goals

Environmental goals have been identified for each site to assist in environmental design and provide standards for measuring success. These goals are premises used to bring about the desired ecological condition at any given site(s). The four goals applied for this process are:

- Restoration;
- Enhancement;
- Creation; and
- Rehabilitation.

Although restoration has been identified as the preferred outcome for riparian and aquatic habitats, it should not be the only measure of success. Considering the alteration of the river valley, broadening the goals to include enhancement, creation, and to some extent, rehabilitation, provides a realistic approach to addressing the MOU which seeks restoration of native riparian and aquatic habitats as well as the restoration of natural fluvial processes.

The alternatives set the framework for implementing a suite of actions; while environmental goals define what is reasonable expectations for a specific area based on current condition, mission requirements, and other constraints (land use, hydrology, etc.). For instance, a goal of “restoration” of the Upper Rincon can only be achieved under alternatives, which provide for restoration actions. On the other side, Alternative 5 provides for watershed restoration actions; however implementing these actions in highly urbanized areas (El Paso) are unlikely due to overriding mission requirements of flood control.

Table 5.1 shows which actions are associated with the environmental goals. Grouping actions by environmental goals helps identify types of actions appropriate for a goal. Some actions (e.g., improve water quality, water conservation) can be a function of several types of environmental goals while others are clearly exclusive; such as seasonal peak flows are exclusive to restoration. Determining the types of environmental actions for a specifics area guides site selection as well as sets expectations. Once sites and actions are identified, measures can be determined for prioritizing selection of sites and ultimately the evaluation actions.

Table 5.1 Cross Reference of Actions by Type of Environmental Goal

Summary of Actions	Environmental Goals			
	Restoration	Enhancement	Creation	Rehabilitation
Restore floodplain by levee setbacks	X			
Sediment Control Structures	X	X	X	
Bank overflow by shave downs or passive restoration actions	X			
Allow seasonal peak flows and associated impacts (Active restoration action)	X			
Modify dredging and spoil disposal	X	X		
Reduce runoff/ Erosion control dams	X	X		
Widen Channel and back-water habitat	X	X		
Control invasive vegetation	X	X		
Expand existing no-mow zones	X	X		
Interagency cooperation agreements	X	X		X
Discontinue leases	X	X		
Channel splits and meanders	X	X	X	
Planting sites	X	X	X	
Improve water quality, water conservation	X	X	X	X
Create white-water fish habitat		X	X	
Expand existing groin, weirs, and embayment		X		
Enhance wetlands		X		
Land purchases for habitat		X		
Create wetlands			X	
Add recreational areas				X

5.4 Environmental Measures

The measure for evaluating environmental goals is based on the type and amount of habitat produced. While recognizing that the ideal measure is one which evaluates the functional processes (change of) of a system, calculating habitat and quality of the habitat is a more direct and repeatable method of evaluation. The measure used is the amount of upland, wetland, riparian, and aquatic habitat produced relative to current conditions and proposed (reference site) conditions. Habitat is quantified using the previously described concept of habitat units. Two techniques to calculate HUs are employed, one for the upland, wetland, and riparian habitat, and a second for the aquatic habitat.

5.4.1 Uplands, Riparian and Wetland Habitat Units

The Wildlife Habitat Appraisal Procedure (WHAP) was developed by TPWD to allow a quantitative, holistic evaluation of wildlife habitat for particular tracts of land statewide without imposing significant time requirements.

WHAP is intended as a tool to be used to develop baseline data, evaluate impacts on wildlife of specific Project alternatives, and compare the wildlife value of different habitats. WHAP requires evaluating representative sites within each cover type in the Project area. Potential restoration and enhancement sites were surveyed as part of the EIS using the WHAP Biological Habitat Components Evaluation Key to assign habitat value (points). Two surveys were conducted, one in May 2000, and one in September 2000. Table 5.2 lists WHAP values for major vegetation communities. Examples of criteria to be looked at include the presence of hydric soils, age or maturity of the plant community, uniqueness of wildlife values, species diversity, and structural diversity.

Table 5.2
WHAP Values for Major Vegetation Communities Based on Field Surveys

Association	Number of WHAP Surveys	Average WHAP Score
Uplands		
Herbaceous	62	32
Shrub/Scrub*	0	0
Agricultural	9	31
Riparian		
Salt cedar	16	54
Willow/Seepwillow	25	56
Riparian Herbaceous	10	52
Riparian Woodland	4	56
Wetlands	5	57

*Upland shrub/scrub habitat is located outside of the floodway. Evaluations will be conducted as part of the WHAP/HEP report.

Habitat component point values and Habitat Suitability Scores were estimated for each vegetation community. The Habitat Suitability Scores were used to calculate HUs (= Habitat Suitability Score x Habitat Quantity) and make comparisons to determine habitat units impacted by each alternative examined.

The WHAP scores were summarized by vegetation community to develop an overall estimate of the terrestrial, riparian, and wetland habitat values across the Project area (Table 5.3). The generalized method presented for this Alternatives Report is intended to provide uniform standard for analysis of sites.

Table 5.3
Habitat Types Used for Alternatives Analysis and Estimated WHAP Values

Habitat Type	Estimated WHAP Score for Existing Condition	Potential WHAP Score for Native Mature Habitat
Upland	0.15 - 0.30	0.6
Riparian	0.20 - 0.55	0.9
Wetland	0.30 - 0.57	0.9

The estimated WHAP Score for existing conditions is used to estimate habitat units for a site. The potential WHAP score for native mature habitat is a score assigned to a site based on site potential (reference site) after implementing environmental actions.

5.4.2 Aquatic Habitat Units

The Habitat Evaluation Procedure (HEP) was developed by the United States Fish and Wildlife Service (USFWS) (USFWS 1980). HEP is a habitat-based approach for assessing environmental impacts of proposed water and land resource development projects. Habitat quality for selected evaluation species is documented with a Habitat Suitability Index (HSI). An HSI value is derived from evaluation of the ability of key habitat components to supply life requisites of selected species of fish. As part of the EIS, an initial HEP was conducted for the Canalization Project during high flow (irrigation flow) conditions. Final habitat suitability scores will be completed after the winter (low-flow) aquatic habitat and species composition survey in January 2001.

Based on initial HEP surveys, the entire Project lacks habitat diversity and essential habitat features required to sustain diverse aquatic species. This condition is evidenced in the overall uniformity of bottom type, lack of backwater, low current areas, and lack of riparian habitat. Some exceptions exist where natural arroyos or agricultural return flows provided habitat dissimilar to that in the main channel.

Biological diversity and species abundance in streams depend on availability of diverse habitats (USEPA 1998). By extrapolating HEP results to the WHAP scale (no direct correlation between HEP and WHAP exists, but a general approximation was made), with 0.0 representing the poorest habitat conditions and 1.0 representing ideal native aquatic habitat, the Project aquatic habitat ranks mostly as 0.15. Again, HEP is species-specific, and generalities have been made to normalize initial HEP results with WHAP data for the purposes of initial habitat analyses for this report. Areas with vortex weirs, groins, embayment, and siphons reflect slightly higher scores (0.4 modified HEP score). These areas provide increased levels of dissolved oxygen, increases in visual and hydraulic cover, and increased bottom substrate stability. Increasing hydraulic variability increases the aquatic diversity through changes in visual cover, hydraulic cover, and increased dissolved oxygen content. For purposes of evaluation potential through aquatic reference communities, a score of 0.9 is estimated for aquatic habitat exhibiting highly diverse attributes.

5.4.3 Assignment of Habitat Unit Weights

WHAP and modified HEP values are combined to give an approximate evaluation of existing habitat. The purpose of developing combined habitat unit weights is to provide a uniform standard for ranking sites and eventually, as WHAP and HEP values become refined, a tool to measure success of actions. Table 5.4 lists the combined WHAP/HEP scores for current conditions and potential conditions. The estimated WHAP/HEP score for current habitat is used to calculate current habitat units for a site. The potential WHAP/HEP score for native mature habitat is a score assigned to a site based on successful restoration and enhancment actions.

Table 5.4
Habitat Types Used for Alternatives Analysis and Estimated WHAP/HEP Values

Habitat Type	Estimated WHAP/HEP Weights of Current Habitat	Potential WHAP/HEP Weights for Native Mature Habitat
Uplands	0.15 - 0.30	0.6
Riparian	0.20 - 0.55	0.9
Wetland	0.30 - 0.57	0.9
Aquatic	0.15 - 0.40	0.9

SECTION 6
POTENTIAL ENHANCEMENT AND RESTORATION LOCATIONS

6.1 Management Units

6.1.1 The Concept of Management Units

The Project area has been divided into geographically distinct reaches or management units to allow for a direct comparison of the five alternatives. Management units provide three major functions:

1. Provide a constant measure in the subsequent EIS;
2. Logically divide the river into discrete management strategies; and
3. Determine river recommendations (where and why sites are selected).

The diverse nature of the project area requires formulating specific environmental goals for each management unit. For instance, environmental goals of a management unit located in urban or flood risk areas will largely be dictated by the project mission objectives of flood control. A management unit outside of urban areas and sites determined to have little risk of levee overtopping during flood events will have greater flexibility in environmental options. Table 6.1 lists the management units identified for the Canalization Project. Figure 6.1 shows the location of the management units.

Table 6.1 Management Units and Goals

Management Unit	Location	Major Mission Constraints	Environmental Goals
Upper Rincon Valley	Below Percha Dam to Section number 90.5	Potential flood control issues	Restoration, enhancement, creation
Lower Rincon Valley	Section number 90.5 to Seldon Canyon	Flood control and water delivery	Enhancement, creation
Seldon Canyon	Seldon Canyon to Leasburg Dam	Minimal	Enhancement, creation
Upper Mesilla Valley	Leasburg Dam to Section number 50.5	Flood control	Restoration, enhancement, creation
Las Cruces	Section number 50.5 to Interstate 10	Major flood issues	Enhancement, rehabilitation, creation
Lower Mesilla Valley	Interstate 10 to New Anthony Bridge	Flood control	Restoration, enhancement, creation
El Paso	New Anthony Bridge to American Dam	Major flood issues	Enhancement, rehabilitation, creation

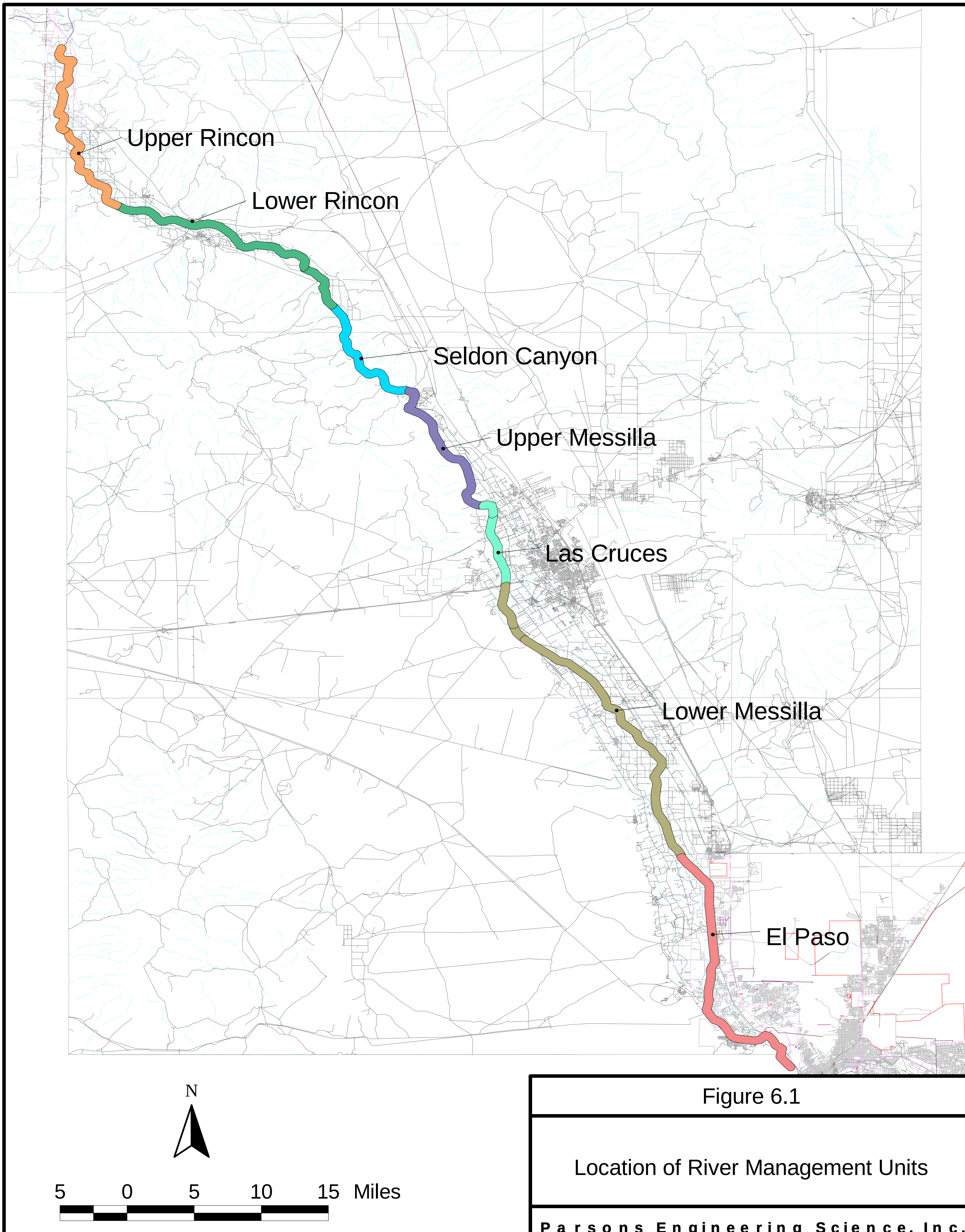


Figure 6.1

Location of River Management Units

Parsons Engineering Science, Inc.

6.1.2 Characterization of the Management Units

The process of characterizing management units includes summarizing information about surrounding land use, channel morphology, hydrology, and vegetation. Characterization includes:

- Structures - Levees, diversion dams, siphons, and bridges which must be considered as influencing actions or being impacted by enhancement/restoration actions;
- Land use - Surrounding land use such as agricultural, urban areas, and range land;
- Hydrology - Flow regimes, discharge rates, flow duration, and subsurface water regimes;
- Erosion and sedimentation - Dominant erosion processes, sedimentation, and bank erosion issues;
- Vegetation - Status of riparian vegetation along banks and floodplain, transitional upland fringe vegetation, aquatic vegetation, and wetlands;
- Channel processes - Channel width, size, depth, and floodplain connectivity;
- Corridor dimension - includes width, topography, and sinuosity; and
- Ecological functions and values to restore and enhance as identified in Section 5.1.2.

6.2 Description of River Management Units

The following sections describe each management unit and list the management unit potential, as well as a tabulated summary of degradation causes which can be addressed, ecological functions and values to be restored and enhanced, and environmental goals.

6.2.1 Upper Rincon Valley River Management Unit

<u>Characterization</u>

Description - The management unit is a 16.5-mile stretch of river located between Percha Dam at the north end and cross section number 905 at the south. It is the least populated segment of the Canalization Project, with large tracts of right-of-way lands and adjacent BLM lands on the east and west sides. It includes more than 2,830 acres of potential restoration and enhancement areas inside the right-of-way, and 487 acres outside the right-of-way.

Structures - There are no constructed levees north of the Doña Ana County line. A 7-mile levee on the east side extends from the Doña Ana County line south to the end of the management unit boundary. The low flow channel is armored with rip-rap to varying degrees along the channel. Eight mitigation sites are present in the management unit. There are two bridges, including Arrey and Garfield.

Land use - The Upper Rincon is above the Doña Ana County line and is currently managed as a no-mow zone. The management unit is bounded on the east and west sides by agricultural lands within upper areas. On the levied portion (lower 9.5-mile area), the east side levee separates contiguous agricultural lands (the majority of which are seasonal crops) with the west side dominated by extensive BLM tracts and USIBWC lands leased for grazing.

Hydrology -The highest flow rates of the Canalization Project are found below Percha Dam during water delivery periods. The management unit contains seven major contributing creeks; Trujillo Arroyo, Montoya Arroyo, Tierra Blanca Arroyo, Sibley Canyon Arroyo, Green Canyon Arroyo, Berrenda Creek, Jaralosa Arroyo, Crow Arroyo, and McLeod Draw.

Erosion and Sedimentation - Sedimentation occurs at the mouths of the arroyos. This tends to divert the river flow against the opposite bank, which is subject to erosion if not effectively armored. Erosion may also occur on the same bank as the arroyo mouth but downstream from the arroyo as the flow deflects back across the river.

Vegetation - Remnant riparian vegetation exists in pockets concentrated in the northern end of the management unit adjacent to Percha Dam State Park. A fringe of vegetation is established in many grazed or mowed areas providing limited bank stabilization.

Channel Processes - The riverbanks are generally elevated above the water surface by 5 to 10 feet in this reach. Significant sedimentation occurs in this reach due to contributions from large arroyo watersheds. This material must be removed to keep the river flowing in the USIBWC right-of-way. Sediment disposal outside the right-of-way is a problem due to the lack of available space.

Corridor and Right-of-way Dimension - The width of the USIBWC right-of-way varies from 750 feet to about 1,250 feet until Jaralosa Arroyo where extensive uplands are included within the right-of-way. A second large upland tract is located within the Crow Canyon Arroyo on the west side of the river.

Potential

The Upper Rincon management unit has opportunities for riparian restoration and as a riparian corridor linking surrounding uplands and remnant pockets of bosque. The management unit has the greatest potential for large-scale restoration actions within the Canalization Project. Restoration actions emphasize passive and active approaches emulating natural hydrologic regimes through timed releases of irrigation water. The management unit includes five old meanders within the right-of-way that were cut off by canalization during construction. Acquisition of a 350-acre tract within the Jaralosa Arroyo watershed could restore extensive floodplain modification on the west side of the river.

Table 6.2 Summary of Environmental Goals and Potential Improvements for the Upper Rincon Valley River Management Unit

Degradation Causes Addressed (Alternative Dependent)		Ecological Functions/Values to be Restored/Enhanced (Alternative Dependent)		Environmental Goals	
x	Maintenance practices	x	Corridor development	x	Restoration
x	Grazing	x	Terrestrial ecotone connectivity	x	Enhancement
x	Invasive species	x	Wildlife and fisheries habitat	x	Creation
x	Canalization		T&E species habitat		Rehabilitation
x	Hydrographic changes	x	Streambank stabilization		
x	Floodplain reduction		Urban stream buffers		

6.2.2 Lower Rincon Valley River Management Unit

Characterization

Description – The management unit is an 18-mile length of the river dominated by agricultural (primarily row crops) on either side of the river. The management unit is considered marginal for restoration due to a levee overtopping potential, water delivery structures, and an extensive amount of private lands. The management unit includes more than 598 acres of potential enhancement sites inside the right-of-way, and 256 acres outside the right-of-way.

Structures – Rincon Siphon, Hatch Siphon, and 31 miles of levees characterize the management unit. Five mitigation sites are present. The management unit includes the following bridges: Salem, Hatch (USJ85 and NMV26), Atchison, Topeka, and Santa Fe Railroad, Hatch-Rincon (NMV140 and HWY 154), New Rincon, and Tonuco.

Land use – The entire management unit is mowed. Agriculture dominates the landscape with few areas that transition into large BLM tracts. Narrow bands of agriculture separate BLM tracks from the right-of-way along the unleveed lower west side. Angostura Arroyo provides some connectivity between uplands, arroyo habitat, and the river corridor.

Hydrology – The management unit contains seven major contributing arroyos: Placitas Arroyo, Spring Canyon, Rodey Arroyo, Rincon Arroyo, Angostura Arroyo, Reed Arroyo, and Bignell Arroyo. Extensive flooding of agriculture lands is possible along the southerly unleveed west bank, unleveed west bank north of Rincon Bridge, and in the east side of Garfield Drain.

Erosion and Sedimentation – The arroyos contribute extensive amounts of sediment into the river. Integrity of the siphons due to erosion is a major concern.

Vegetation - Remnant riparian vegetation exists on private lands adjacent to the right-of-way. The majority of the right-of-way is dominated by upland and riparian herbaceous communities. Mowing has suppressed the majority of salt cedar from dominating the entire area between the channel and levee. A diversity of vegetation can be found along the Angostura Arroyo, Reed Arroyo, and Bignell Arroyo.

Channel Processes – There appears to be little modification in channel sinuosity since project construction. No bends or meanders appear to have been straightened during construction.

Corridor Dimension – The width of the right-of-way varies from about 700 feet to 800 feet. The right-of-way becomes significantly wider at the confluence of the Angostura Arroyo and the main channel of the Rio Grande and extends from the corridor at Reed Arroyo and Bignell Arroyo.

Potential

The Lower Rincon management unit has riparian and aquatic enhancement opportunities for improving the riparian corridor between the Upper Rincon and Seldon Canyon, connecting upland habitat with the riparian corridor and creating wetlands. A 2.5-mile old river meander is located on private land east of the river. The Angostura Arroyo site (private) includes a portion of the meander as a potential site. Several wetland creation areas inside the right-of-way are proposed.

Table 6.3 Summary of Environmental Goals and Potential Improvements for the Lower Rincon Valley River Management Unit

Degradation Causes Addressed (Alternative Dependent)		Ecological Functions/Values to be Restored/Enhanced (Alternative Dependent)		Environmental Goals	
x	Maintenance practices	x	Corridor development		Restoration
x	Grazing	x	Terrestrial ecotone connectivity	x	Enhancement
x	Invasive species	x	Wildlife and fisheries habitat	x	Creation
	Canalization		T&E species habitat		Rehabilitation
	Hydrographic changes		Streambank stabilization		
	Floodplain reduction		Urban stream buffers		

6.2.3 Seldon Canyon River Management Unit

Characterization

Description - The Seldon Canyon management unit is a 9-mile section bounded by Seldon Canyon ending at Leasburg Dam State Park. The management unit is currently managed as a no-mow zone. The management unit is adjacent to private property that contains habitat for an endangered bird species, the Southwestern willow flycatcher. The very limited right-of-way restricts options outside of the channel; therefore, restoration options, although listed as a potential goal, are limited.

Structures – There are no structures within the management unit.

Land use – Extensive undeveloped lands (BLM, New Mexico State and private) buttress the river corridor. Considerable topographic relief has restricted agriculture conversion of the area. The management unit is managed as a green zone.

Hydrology – The management unit contains three major arroyos, Broad Canyon, Foster Canyon, and Faulkner Canyon.

Erosion and Sedimentation – Sedimentation at Leasburg Dam has widened the river and created extensive islands even at high flows. The process of sediment accumulation followed by vegetation of islands is readily apparent north and west of Leasburg Dam.

Vegetation - Extensive and mature salt cedar woodlands were found along the Broad Canyon confluence with the river. The majority of non-uplands acreage is privately held. Previous studies and recent field visits found potential Southwestern willow flycatcher habitat.

Channel Processes - The channel path in Seldon Canyon was not modified during the Project construction. Sediment removal has been conducted in the canyon.

Corridor Dimension – The river corridor ranges between 300 and 1,500 feet in width. The riparian zone is clearly visible in aerial photographs by the sharp contrast between salt cedar dominated communities and upland shrub scrub areas.

<u>Potential</u>

The river management unit has limited right-of-way and extensive private lands adjacent to the river. Previous studies have documented habitat for Southwestern willow flycatcher within the management unit. This management unit includes the purchase of 60 acres of farmland adjacent to Dead Man’s Curve for conversion to wetlands, bosque, and threatened and endangered species habitat. In addition, the management unit includes Leasburg Dam State Park, which has extensive salt cedar bosques and potential Southwestern willow flycatcher habitat. Cooperative management agreements to reduce grazing and management for threatened and endangered species habitat hold the most promise. Expansion of a small park area (4 acres) in the existing complex is possible.

Table 6.4 Summary of Environmental Goals and Potential Improvements for the Seldon Canyon River Management Unit

Degradation Causes Addressed (Alternative Dependent)		Ecological Functions/Values to be Restored/Enhanced (Alternative Dependent)		Environmental Goals	
x	Maintenance practices		Corridor development		Restoration
x	Grazing		Terrestrial ecotone connectivity	x	Enhancement
x	Invasive species	x	Wildlife and fisheries habitat	x	Creation
	Canalization	x	T&E species habitat		Rehabilitation
	Hydrographic changes		Streambank stabilization		
	Floodplain reduction		Urban stream buffers		

6.2.4 Upper Mesilla Valley River Management Unit

Characterization

Description - The Upper Mesilla management unit is a 12-mile length of the river extending from Leasburg Dam State Park to the outskirts of Las Cruces at Salem Colony Bridge. Levees on the east side and extensive BLM holdings on the west define the management unit. Sites include a total of 214 acres within the right-of-way and 56 acres of potential acquisitions.

Structures – The east side of the river has over 9 miles of maintained levees. Leasburg Dam, Leasburg Bridge, and Picacho Flume are within the management unit.

Land use – The entire east side of the river is agricultural. Extensive pecan orchards dominate the agricultural mosaic.

Hydrology – Other than upstream water flows, the management unit is influenced by Apache Canyon and two wasteways (Wasteway 2 and Wasteway 2A).

Erosion and Sedimentation – Water velocities are less than the northern management units, having been reduced through attenuation and water diversions at Leasburg Dam. This management unit has relatively few arroyos contributing sediment to the river. Significant sediment deposits within the management unit are designated for removal by USIBWC.

Vegetation - The majority of the east right-of-way is dominated by upland and riparian herbaceous communities. Mowing has suppressed the majority of salt cedar from dominating the entire area between the channel and levee. Vegetation on the west side right-of-way has been grazed and appears to be partially mowed along the level floodplain. Several large dense salt cedar bosques are found on the west side with mature and declining cottonwoods found within the bosques. There is little indication of cottonwood re-growth. Pole planting has been attempted on the east side near Wasteway 2-A and across the river from the Channel Cut enhancement site.

Channel Processes - The major modification of channel sinuosity is a 0.8-mile meander straightened during project construction.

Corridor Dimension - The corridor ranges between 800 and 1,500 feet in width.

Potential

The most significant attribute of the management unit is the uninterrupted connectivity between BLM lands and the west side of the river corridor. This provides restoration (passive) opportunities for a previous channel cut (0.8 miles in length) on the west side. In addition, modifying grazing practices along with salt cedar control on the west side could improve wildlife habitat and terrestrial ecotone connectivity. An area containing over 300 acres within the right-of-way could be enhanced. Interagency agreements concerning grazing along the west side could be required. The original estimate of 214 acres of sites inside the right-of-way can be increased considerably by incorporating the entire west side as a site.

Table 6.5 Summary of Environmental Goals and Potential Improvements for the Upper Mesilla Valley River Management Unit

Degradation Causes Addressed (Alternative Dependent)		Ecological Functions/Values to be Restored/Enhanced (Alternative Dependent)		Environmental Goals	
x	Maintenance practices	x	Corridor development	x	Restoration
x	Grazing	x	Terrestrial ecotone connectivity	x	Enhancement
x	Invasive species	x	Wildlife and fisheries habitat	x	Creation
x	Canalization		T&E species habitat		Rehabilitation
	Hydrographic changes		Streambank stabilization		
	Floodplain reduction		Urban stream buffers		

6.2.5 Las Cruces River Management Unit

Characterization

Description - Urbanization and heightened need for flood control are the major issues. The management unit begins at Shalem Colony Bridge and extends south for 9 miles to Interstate Highway 10. The Las Cruces management unit is characterized by development and agriculture. Flood risks constrain environmental actions, which could increase flooding potential.

Structures – Over 18 miles of levees bound the east and west side of the river. Shalem, Picacho (U.S. 70, 80 and 180), and Interstate Highway 10 bridges cross the channel within the management unit.

Land use – Land use is composed of an urbanized/agricultural matrix. The upper two-thirds of the management unit is managed as a green zone, which extends throughout all the management unit site locations.

Hydrology – Box Canyon is the primary arroyo entering the river. Several wasteways (Wasteways 4, 6, and 10) provide some opportunities for enhancement.

Erosion and Sedimentation – Erosion and sedimentation are not significant in this unit.

Vegetation – The majority of the right-of-way is dominated by upland and riparian herbaceous communities. Mowing has suppressed the majority of salt cedar from dominating the entire area between the channel and levee.

Channel Processes – A 0.6-mile meander was straightened on the east side north of Wasteway 39.

Corridor Dimension - The river corridor ranges between 700 feet and 1,100 feet in width.

<u>Potential</u>

Las Cruces provides significant opportunities for managing the right-of-way in a multiple-use manner. Overriding flood control concerns limit actions which could aggravate flooding. Furthermore, urbanization adjacent to the levee reduces future control options of raising levees rather than levee setbacks. Despite urbanization constraints, considerable improvements in the form of recreation areas and selective habitat are possible. Local agency cooperation is required to fully realize this potential. For this unit, emphasis is on enhancing and creating habitat associated with wasteways and connecting enhancement sites within the current no-mow zone. Further mowing reductions should include alternative salt cedar control.

Table 6.6 Summary of Environmental Goals and Potential Improvements for the Las Cruces River Management Unit

Degradation Causes Addressed (Alternative Dependent)		Ecological Functions/Values to be Restored/Enhanced (Alternative Dependent)		Environmental Goals	
x	Maintenance practices		Corridor development		Restoration
x	Grazing		Terrestrial ecotone connectivity	x	Enhancement
x	Invasive species	x	Wildlife and fisheries habitat	x	Creation
	Canalization		T&E species habitat	x	Rehabilitation
	Hydrographic changes		Streambank stabilization		
	Floodplain reduction	x	Urban stream buffers		

6.2.6 Lower Mesilla Valley River Management Unit

<u>Characterization</u>

Description – The Lower Mesilla Valley begins at Interstate Highway 10 and extends south 25 miles to New Anthony Road. The Lower Mesilla unit is dominated by agriculture on both sides of the river. The northern part of the management unit is characterized by extensive pecan orchards, and the southern portions are primarily cultivated in seasonal crops.

Structures – Levees bound both sides of the management unit with the exception of a 2-mile stretch located on the west side of the river north of Mesilla Dam. Bridges include Mesilla, Santo Tomas (NM 28), Mesquite (NM 228), Vado, Berino, and Old Anthony.

Land use – There is extensive grazing and mowing throughout the management unit.

Hydrology – Several wasteways feed into the river (Wasteways 104 - 115).

Vegetation - The majority of the right-of-way is dominated by upland and riparian herbaceous communities. Mowing has suppressed the majority of salt cedar from dominating the entire area between the channel and levee.

Channel Processes - Seven old bends were cut off by canalization during construction; all but one are mostly outside the right-of-way.

Corridor Dimension – The corridor is virtually uniform in width, averaging 650 feet. There is remarkably little variability throughout the management unit in overall dimensions.

Potential

With the exception of an enhancement site proposed by SWEC (NMGF/Picacho Bosque site), opportunities are restricted to isolated wasteways and drains. However, due to private landowner involvement, the NMGF site presents an opportunity for passive restoration of over 150 acres of bosque and wetlands. The NMGF site could involve levee setbacks, re-establishing meanders, and over bank flooding through passive processes.

Table 6.7 Summary of Environmental Goals and Potential Improvements for the Lower Mesilla Valley River Management Unit

Degradation Causes Addressed (Alternative Dependent)		Ecological Functions/Values to be Restored/Enhanced (Alternative Dependent)		Environmental Goals	
x	Maintenance practices	x	Corridor development	x	Restoration
x	Grazing	x	Terrestrial ecotone connectivity	x	Enhancement
x	Invasive species	x	Wildlife and fisheries habitat	x	Creation
	Canalization		T&E species habitat		Rehabilitation
	Hydrographic changes	x	Streambank stabilization		
x	Floodplain reduction		Urban stream buffers		

6.2.7 El Paso River Management Unit

Characterization

Description – The management unit begins at New Anthony Road and extends south 20 miles to American Dam. Urbanization and flood control problems are the major issues.

Structures – Levees bound both sides of the river with the exception of a 4.5-mile length on the west side of the river beginning at Anapra Bridge progressing northward. Flood protection is afforded by natural relief along this section. Structures in the management unit also include New Anthony, Vinton, Canutillo, Borderland, Artcraft, County Club, Anapra, Brickplant, and Courchesne Bridges.

Land use – Land use is primarily urbanized with a mix of agricultural in the northern section of the management unit. As in Las Cruces, many of the floodway areas are used as recreational areas.

Hydrology – Several wasteways (Wasteways 116 – 128) provide some opportunities for enhancement.

Vegetation - The majority of the right-of-way is dominated by upland and riparian herbaceous communities. Mowing has suppressed the majority of salt cedar from dominating the entire area between the channel and levee.

Channel Processes - Some of the most extensive changes to the river occurred in the El Paso area. The Vinton Cutoff was completed prior to Project construction and significantly straightened the river. The old meander, approximately 3.5 miles in length, is mostly situated on land owned by the El Paso Utilities/Public Service Board.

Corridor Dimension – The channel is similar in dimension to that of the Lower Mesilla Valley, rarely exceeding 800 feet in width.

Potential

El Paso provides significant opportunities for managing in a multiple-use manner. Overriding flood control concerns limit actions which could aggravate flooding. Furthermore, urbanization adjacent to levees reduces future flood control options to raising levees rather than setting back levees. Despite urbanization constraints, considerable improvements in the form of recreation areas and selective habitat are possible. Local agency cooperation is required to fully realize potential. Emphasis is on enhancing and creating habitat associated with wasteways. Reducing mowing in conjunction with salt cedar control is a primary action for the management unit. A significant opportunity to enhance native cottonwoods exists in the Sunland Park area. Selective mowing over the years has allowed cottonwoods to regenerate naturally. The potential for a native cottonwood stand to develop within an urban environment would be a major achievement.

Table 6.8 Summary of Environmental Goals and Potential Improvements for the El Paso Management Unit

Degradation Causes Addressed (Alternative Dependent)		Ecological Functions/Values to be Restored/Enhanced (Alternative Dependent)		Environmental Goals	
x	Maintenance practices		Corridor development		Restoration
x	Grazing		Terrestrial ecotone connectivity	x	Enhancement
x	Invasive species	x	Wildlife and fisheries habitat	x	Creation
	Canalization		T&E species habitat	x	Rehabilitation
	Hydrographic changes		Streambank stabilization		Mitigation
	Floodplain reduction	x	Urban stream buffers		

6.3 Potential Enhancement and Restoration Locations

6.3.1 Site Selection

Forty-eight sites along the 105-mile project area were suitable for implementing various environmental actions. Most sites are composed of several separate tracts of land (e.g., either side of the river, closely situated drains, etc.). A total of 6,645 acres were identified for potential environmental restoration, enhancement, creation, or rehabilitation. Almost 5,464 acres (out of a possible 11,100) were identified inside the right-of-way, and an additional 1,178 acres of land were identified as possible acquisition property. These figures do not include the thousands of acres which could be improved through cooperative agreements with other agencies (e.g., BLM), or which would benefit through enhancing the corridor itself. It can be assumed that many areas adjacent or connected to enhancement sites would also benefit environmentally. Table 6.9 is a site summary. Table D.1 in Appendix D shows the actions for each site.

Table 6.9 Site Summary

Site Name	Section Number	Area (acres)	Habitat Units
Upper Rincon Valley River Management Unit			
Oxbow Restoration Site	104.5	24	22
Tipton Arroyo	104.0	35	27
Trujillo Arroyo	103.0	143	104
Montoya Arroyo	101.5	131	119
Holguin Arroyo	101.0	52	35
Green / Tierra Blanca	99.4	94	72
Sibley Arroyo Point Bar	98.0	93	62
Jaralosa Arroyo	96.4	1,276	744

Site Name	Section Number	Area (acres)	Habitat Units
Yeso Arroyo	93.5	157	130
Crow Canyon	92.0	1,428	600
Lower Rincon Valley Management Unit			
Hatch Siphon	90.0	36	22
Wetlands Unit B	89.0	34	17
Wetlands Unit A	87.0	25	15
Garfield Drain	86.0	47	32
Placitas Arroyo	84.5	230	137
Remnant Bosque/Rincon	82.2	232	140
Angostura Arroyo	80.0	224	128
Rincon/Reed Arroyo	78.3	114	72
Bignell Arroyo	76.0	143	86
Seldon Canyon River Management Unit			
Dead Man's Curve	69.0	61	30
Broad Canyon	67.0	55	32
Leasburg Dam	62.0	6	5
Upper Mesilla Valley River Management Unit			
West Side	57.5	220	120
Levee Setback	56.5	68	45
Seldon Drain	55.5	16	11
Channel Cut	54.5	373	219
Wasteway No. 2A	52.5	36	15
Las Cruces River Management Unit			
Wasteway No. 5	50.0	36	21
Wasteway No. 39	48.5	47	25
Wasteway No. 8	47.5	33	26
Wasteway No. 39A	46.5	44	15
Lower Mesilla Valley River Management Unit			
Clark Lateral	42.5	76	36
NMGF Bosque (Picacho Bosque)	41.5	230	165
Mesilla Dam	39.5	16	10
Pole Planting Area	34.0	40	17
Wasteway No. 18	29.5	71	43
Del Rio Drain	26.5	70	42

Site Name	Section Number	Area (acres)	Habitat Units
Wasteway No. 19	25.5	39	21
Old Channel	25.0	95	53
Wasteway Nos. 31 and 20	22.0	17	12
El Paso River Management Unit			
Jimenez and Three Saints Lateral	19.5	82	52
East Drain	16.0	50	30
Wasteway No. 34	10.0	2	2
Wasteway No. 35	9.0	35	25
Nemexas Drain	7.0	51	34
Sunland Park	5.0	92	67
Cottonwood Grove	4.0	60	40
Anapra Bridge	3.0	98	47
Total Area		**6,645**	**3,821**

6.3.2 Upper Rincon Valley River Management Unit

Site 104.5 Oxbow Restoration

Description

South of Percha Dam and south of mile 105 is a meander that was blocked off with a dike during Project construction. This oxbow was originally the main channel of the river until the current channel was excavated. The site is within the right-of-way.

Proposed Actions

Flow through the old oxbow could be restored and wetlands could be created if the dike was removed. The old channel could be partially excavated to create the hydraulic profile needed for additional flow. This will create aquatic, wetlands, and/or riparian habitat. Of the 15 acres of current riparian shrub/scrub and woodlands, 4 acres would be converted to aquatic habitat and 8 acres restored to native riparian woodland. Additional plantings could be required to establish desired riparian species composition. Seasonal peak flows that simulate the natural hydrograph could have a significant effect with regard to the establishment of riparian vegetation.

Site 104 Tipton Arroyo

Description

On the eastern shore, opposite a point bar, is the mouth of Tipton Arroyo. The mouth of the arroyo has been excavated to remove the "fan" of sediments entering the river. As of June 2000, the mouth of the arroyo was a small embayment that contained some wetlands vegetation. The watershed draining to Tipton Arroyo encompasses 2.2 square miles with numerous drainage channels leading from uplands to the east. The channels flow under U.S. Interstate 25 and combine into Tipton Arroyo near the Rio Grande. Two channels have small sediment control dams across them, referred to as Caballo Dam No. 1 and Underwood Dam.

A point bar south of Percha Dam opposite the arroyo at mile 104 on the west side of the river covers about 17 acres. The area is within the right-of-way and is approximately 5 to 10 feet above the water surface. It reportedly has not been mowed for about 5 years and has old-growth herbaceous shrub and grass vegetation but few trees. Some wetlands exist south of the point bar on the west bank of the river.

Proposed Actions

Additional erosion control within the arroyo watershed would reduce the sediment load to the river at this point. This could include erosion control measures on the arroyo banks, establishing vegetative cover, or other watershed management measures. Additional sediment control dams on the channels leading to Tipton Arroyo would also reduce the impact of floodwaters. Sediment disposal sites outside the floodway are needed for channel maintenance. Dredging practices could be modified to allow for gravel, cobble, and boulders to remain in the channel or to be added to the channel for aquatic habitat.

By excavating or "shaving down" the eastern bank of the point bar, the site would exhibit a gradual slope to the channel bottom. The gradual slope will promote a transition of vegetation allowing for a succession of vegetated communities to extend along the shore ranging from wetlands to uplands.

Native riparian vegetation planting in conjunction with tamarisk control would restore over 20 acres of native bosque. Although the density of tamarisk is relatively low in this area, invasive species control must be practiced using control methods other than mowing. Native uplands vegetation can be established at higher elevations, providing a diversity of habitats.

Increasing the average channel width would reduce water velocities and improve aquatic habitat. Installation of groins or vortex weirs improving up to 4 acres of aquatic habitat will provide relatively still water areas for aquatic species during high flow conditions.

Site 103 Trujillo Arroyo

Description

The mouth of Trujillo Arroyo is on the western bank of the river at mile 103. The channel for Nordstrom Arroyo, which is north of Trujillo Arroyo, has been diverted south to combine with Trujillo Arroyo prior to passing over the Arrey Canal Siphon and entering the floodway. Nordstrom Arroyo has a sediment control dam, but Trujillo Arroyo does not. Trujillo Canyon covers 52.9 square miles and extends for 29.5 miles to the west from the Rio Grande into the Black Range Mountains of the Gila National Forest. The watershed has both steep mountain streams with entrenched arroyos and less steep mesas, draining through braided or meandering streams.

A sandbar has developed from sediment entering the river. The sandbar deflects the flow into the river channel to the east against the riprapped eastern bank. The water velocity is higher downstream of the arroyo due to the presence of the sand bar. Switchgrass is present in the area along with tamarisk.

A rock groin was placed upstream of the arroyo mouth to establish low-velocity aquatic habitat. An embayment was constructed downstream of the arroyo mouth for aquatic habitat and wetlands vegetation. As of June 2000, the embayment has remained relatively free of sediment, possibly due to the large boulders placed at its edge along the river channel.

Proposed Actions

Erosion control in the Trujillo Arroyo watershed would reduce the sediment load to the river at this point. This could include erosion control measures on the arroyo banks, establishing vegetative cover on erosion-prone land, or other watershed management practices. A sediment control dam on the arroyo would also reduce the impact of floodwaters. Sediment disposal sites outside the floodway are needed for channel maintenance.

The arroyo flow and sediment deposition appear to cause the river to intrude into the eastern bank. The eastern bank elevation is 8 to 10 feet above the water surface. Retirement of 44 acres of farmland on the east side of the river opposite the arroyo mouth and removal of the hardening on the eastern bank would allow the river to meander. Restoring the farmland to native bosque would function as erosion control as the river channel moved eastward. This area would provide a wildlife corridor connecting the river with the undeveloped mesa to the east. The western bank would be subject to erosion downstream of the arroyo as the river current deflects off the eastern bank and swings back to the west.

Increasing the average channel width would reduce water velocities and improve aquatic habitat. Installation of groins or vortex weirs will also provide relatively still water areas for aquatic species.

Site 101.5 Montoya Arroyo and Holguin Arroyo

Montoya Arroyo

Description

The mouth of Montoya Arroyo is on the western bank of the river at mile 101.5. The arroyo channel has been straightened and has berms on both sides. The watershed covers 23 square miles and does not have a sediment control dam.

The banks of the arroyo outside the right-of-way are heavily vegetated. The arroyo deposits sediment at this junction and downstream in the river, which was recently excavated. South of the arroyo mouth is a vortex weir that was installed to provide aquatic habitat.

North of the arroyo mouth on the west side of the river at mile 102 is a grazing lease. This part of the right-of-way was originally a part of the river channel with an island separating two channels. The western channel was diked off and filled in during the Project construction. Several acres of wetlands are currently present on the site.

Montoya Arroyo includes 60 acres inside the right-of-way and the potential acquisition of 60 acres of former bosque. The elevation is 5 to 10 feet above the water surface although the southern edge of the tract is lower terrain. The land is leased for grazing and is sparsely vegetated. Willows are present at the water's edge, and a few mature cottonwoods are scattered within the right-of-way. A pole-planting program in 1999 attempted to establish cottonwood saplings.

Proposed Actions

Erosion control in the Montoya Arroyo watershed would reduce the sediment load to the river at this point. This could include erosion control measures on the arroyo banks, establishing vegetative cover on erosion-prone land, or other watershed management practices. A sediment control dam on the arroyo would also reduce the impact of floodwaters. Sediment disposal sites outside the floodway are needed for channel maintenance.

The arroyo flow and sediment deposition appear to cause the river to intrude into the eastern bank. The land elevation at the eastern bank is 8 to 10 feet above the water surface. Removal of the hardening on the eastern bank would allow the river to meander, which would widen the channel. Riprap may need to remain on the west bank downstream from the arroyo mouth to contain the channel and avoid erosion of property outside the right-of-way unless additional right-of-way is purchased. Riparian vegetation can function as erosion control as the river channel moves eastward. The southern part of the right-of-way could be excavated to enhance wetland habitat as well as an area for seasonal overbank flows. Grazing should be removed or restricted to allow native vegetation to propagate. Control of tamarisk and other invasive species must be maintained. Seasonal peak flows induce scouring actions, which will help establish native riparian vegetation.

Increasing the average channel width would reduce water velocities and improve aquatic habitat. Installation of groins or vortex weirs will also provide relatively still water areas for aquatic species.

Site 101 Holguin Arroyo

Description

A 20-acre tract located on the western edge of the river between Montoya and Holguin Arroyos at mile 101. Just south of this tract on the eastern shore is a mitigation site. Several acres of wetlands are found on the site.

Proposed Actions

Increase aquatic and riparian diversity by creating an island within the channel for riparian vegetation establishment. A channel cut through the right-of-way would provide for water flow on both sides of the island. Seasonal peak flows that simulate the natural hydrograph are an option to establish native riparian vegetation. Planting of native vegetation combined with control of tamarisk will provide wildlife habitat. Curtailing or restricting grazing leases will also encourage native vegetation growth.

Additional weirs or groins will provide aquatic habitat in this area as will a new channel cut through the right-of-way.

Site 99.5 Green / Tierra Blanca Arroyos

Description

Tierra Blanca Arroyo enters the river on the west bank opposite Green Arroyo south of mile 100. Green Arroyo has an erosion control dam designated SCS Dam 1A. Tierra Blanca Arroyo has a watershed of 68.2 square miles and extends westward from the Rio Grande for a distance of 30.2 miles. It is a Class III arroyo in the USACE classification system, meaning it has both steep mountain streams with entrenched arroyos and less steep mesas draining through braided or meandering streams. Tierra Blanca Arroyo deposits sediment within the river that must be periodically dredged.

A vortex weir has been installed downstream of the arroyo mouth. A point bar is within the right-of-way farther downstream near mile 99.5 on the east side of the river. The point bar contains scattered mature cottonwoods.

Proposed Actions

Erosion control in the Tierra Blanca Arroyo watershed would reduce the sediment load to the river at this point. This could include erosion control measures on the arroyo banks, establishing vegetative cover on erosion-prone land, or other watershed management practices. A sediment control dam on the arroyo would also reduce the impact of floodwaters. Sediment disposal sites outside the floodway are needed for channel maintenance.

A channel cut inside the point bar would create an island with water flowing on both sides. Wetland and native riparian vegetation would be established on the shores of the island and corresponding riverbanks. Seasonal peak flows that simulate the natural hydrograph are an option for establishing native riparian vegetation. Control of tamarisk will be necessary until the native vegetation becomes dominant. Reduction or elimination of grazing leases will improve the growth of native vegetation. The site contains several acres of wetlands, which can be enhanced and expanded.

Additional groins and vortex weirs in conjunction with the restored river channel will provide over eight acres of diverse aquatic habitat.

Site 98 Sibley Arroyo

Description

Sibley Arroyo deposits sediment within the river that must be periodically dredged. The eastern side of the river is a large point bar covering 73 acres opposite the mouth of Sibley Arroyo at mile 98. This is on the southern boundary of Green Zone 1 and is just north of the start of the eastern levee. The point bar is about 6 to 7 feet above the water surface. A rock groin has been installed downstream of the arroyo mouth.

Proposed Actions

Erosion control in the Sibley Arroyo watershed would reduce the sediment load to the river at this point. This could include erosion control measures on the arroyo banks, establishing vegetative cover on erosion-prone land or other watershed management practices. A sediment control dam on the arroyo would also reduce the impact of floodwaters. Sediment disposal sites outside the floodway are needed for channel maintenance.

The edge of the point bar could be excavated to slope gradually down to the water surface. A succession of native wetlands, riparian, and upland vegetation could be established or allowed to propagate within the right-of-way to provide habitat. This area is directly opposite an undeveloped area on the western side of the river and would extend a habitat corridor across the river.

Additional groins and vortex weirs in conjunction with the restored river channel will provide over 6 acres of diverse aquatic habitat.

Site 96.5 Jaralosa Arroyo

Jaralosa Arroyo enters the west side of the river channel near mile 96.5 through a channel that diverted flow from its original route. The channel conveys the combined flow of Jaralosa Arroyo and Berrenda Creek, both of which have dams. Despite the dams, the arroyo deposits sediment that creates islands in the river. The Jaralosa Arroyo site includes extensive lands along the arroyo; all within the right-of-way (west side). An are of over 827 acres, the majority of which are upland shrub lands, is included. The site is grazed on both sides of the river. Part of the west side right-of-way has also been leased for cultivation (approximately 60 acres). An embayment of 10 feet by 20 feet was constructed downstream from the arroyo mouth into the western bank of the river. The embayment was not constructed with rock or boulders at its mouth, and sediment has accumulated within the structure.

Proposed Action

An old river meander could be restored within the large right-of-way area to provide aquatic and riparian habitat that expands the existing bosque. Routing the arroyo through its original floodplain would require the purchase of 357 acres of cultivated land. The arroyo was originally re-routed (diversion dam) because farmland was continually being flooded. Purchasing this land would extend the site to over 1,100 acres. Grazing should be removed or significantly reduced in this area to allow native vegetation to be restored. Control of tamarisk would be a significant part of restoration in this area.

Site 93.5 Yeso Arroyo and Remnant Bosque

Remnant Bosque

The USIBWC right-of-way on the western side of the river extends relatively far from the river channel north of Jaralosa Arroyo between miles 95 and 98. BLM owns land abutting the right-of-way to the west. A large remnant bosque is present on the western side of the river. The west bank contains mature scattered cottonwoods and understory mesquite and tamarisk. Tamarisk dominates the east bank.

Yeso Arroyo

The eastern side of the river north of Yeso Arroyo at mile 95 has scattered mature cottonwoods. Eliminating mowing on both sides of the river would provide habitat and allow native wetlands or riparian vegetation in this area to grow. The western right-of-way abuts undeveloped land owned by BLM that would be linked to the unmowed areas on both sides of the river for habitat continuity. An island could be created in the western right-of-way to provide additional riparian habitat. Control of tamarisk must be maintained when mowing is stopped.

Yeso Arroyo has a watershed of 9.5 square miles and extends 6.1 miles to the west. The arroyo deposits some sediment into the river although the load is not as great as

Jaralosa or Tierra Blanca Arroyos. Control of erosion in the watershed could reduce sediment loading on the river.

A rock groin was installed downstream of the mouth of Yeso Arroyo on the western bank of the river to provide aquatic habitat.

Proposed Actions

The Remnant Bosque could be enhanced by controlling invasive species and planting native vegetation. Supplemental watering may be needed to assure successful survival. Partial restoration of the previous river channel will be accomplished by excavating the eastern bank of the river. Alternately, if erosion protection is in place on the eastern bank, it could be removed to allow the river to reestablish the natural bend. Eliminating mowing with additional tamarisk control is suggested for wetlands or riparian enhancement. Extending the no-mow zone within the Yeso site will better link the two largest sites in the project area, Jaralosa and Crow Canyon.

<u>Site 92 Crow Canyon and Channel Cut</u>

Crow Canyon

Crow Canyon and the Channel Cut areas combine to form the largest site in the Project area, over 1,530 acres. The majority of the site is composed of upland shrubland (1,300 acres); however, over 230 acres are located within areas historically occupied by bosque. The majority of the historic bosque was cleared during Project construction and is now classed as riparian herbaceous or tamarix dominated riparian shrubland

A straight, stepped channel extends from Crow Canyon Dam to the west side of the river channel south of mile 93. The mouth of the spillway creates a small wetlands embayment dominated by cattails. The right-of-way on the west side of the river abuts land owned by BLM. The right-of-way on both sides of the river is leased for grazing. The eastern bank of the river contains willow, baccharis, and groundsel.

Channel Cut

A large bend in the river was cut short to straighten the river's path between miles 91 and 92. A large area of right-of-way on the eastern side of the river is currently mowed but not grazed. A few mature and young cottonwoods are growing in this area. Isolated areas contain wetland vegetation indicating a high water table.

Proposed Actions

Currently, water is released from Crow Canyon Dam within approximately 24 hours of entering the impoundment. The flow release practice could be modified to extend the time that water is drained. This may also help establish native vegetation along the drainage route between the dam and the river. This channel could be modified to establish a meandering route that may allow some native vegetation to become established. The right-of-way on the east side can be designated a no-mow zone and grazing can be removed or restricted to allow vegetation to become established. This will create a wildlife corridor within the right-of-way from the east bank toward the west where undeveloped land is available

The old channel could be partially restored by dredging through the right-of-way to create an island for riparian habitat on the eastern right-of-way. Slow moving water in the restored channel could create aquatic habitat. Mowing could be eliminated to allow native vegetation to grow. The undeveloped land on the west side of the river would be linked to the east side for a wildlife corridor.

6.3.3 Lower Rincon Valley River Management Unit

Site 90 Hatch Siphon

Large boulders have been piled immediately downstream of the siphon near mile 90 to partially dam the river flow and create still backwater. This backwater area prevents the siphon from being damaged by erosion. The low-velocity water provides aquatic habitat. The boulders cause an area of rapids as water flows downstream. Sediment accumulated past the boulders has created vegetated islands within the river channel. A project is underway to design a more permanent structure for protection of the siphon. The new structure will reportedly include a fish ladder.

Proposed Actions

Upstream of the siphon a wetlands area has become established on the eastern side of the river within sediment deposited by the low-velocity water. Willow grows on the bank of the river. Tamarisk has become well established in the areas that are not mowed.

Native vegetation could be established in this area by eliminating mowing and controlling tamarisk. The undeveloped area west of the river would be linked to the river for a wildlife corridor.

Site 89 Wetlands Unit A

Wetlands Unit A is a 28-acre site characterized as riparian herbaceous habitat. Existing lateral berms spaced at 100 to 300-foot intervals perpendicular to the river provide a basis for wetland enhancement and creation. Wetland species were observed throughout the site.

Proposed Actions

Enhance and create over 15 acres of wetlands. The berms within the floodway provide an excellent basis for construction of moist soil impoundments and riparian woodlands.

Site 87 Wetlands Unit B

Wetlands Unit B is a 21-acre site characterized as riparian herbaceous habitat. Existing lateral berms spaced at 100 to 300-foot intervals perpendicular to the river provide a basis for wetland enhancement and creation. Wetland species were observed throughout the site.

Proposed Actions

Enhance and create over 15 acres of wetlands. The berms within the floodway provide an excellent basis for construction of moist soil impoundments and riparian woodlands.

Site 86 Garfield Drain

The Garfield Drain (32-acre site) discharges into the river from the east bank south of the Hatch Bridge near mile 86. The right-of-way is relatively wide at this point. The USIBWC does not maintain the drain; EBID cleans and excavates the channel if it becomes obstructed.

Proposed Actions

A wetlands habitat could be constructed by allowing the drain to flow across the right-of-way parallel to the river for some distance before discharging. Mowing should be eliminated to take advantage of the water supply by allowing native wetlands vegetation to establish. Alternatively, an embayment could be constructed at the mouth of the drain to create a low-velocity backwater area for aquatic habitat.

Site 84.5 Placitas Arroyo

Placitas Arroyo enters the river from the west upstream from the New Hatch Bridge near mile 85. A rock groin has been constructed downstream from the mouth of the arroyo. An island with cattails has become established downstream of the groin.

The floodway is at a relatively low elevation compared to the river. The channel was created by installing groins in the old riverbed. Mesquite and willow are growing at the banks of the river along with arundo. Tamarisk has also become established.

Proposed Actions

Additional groins in the existing channel could be used to enhance aquatic habitat. Acquiring a 132-acre cultivated area east of the river and north of the New Hatch Bridge can link adjacent undeveloped uplands to the river. The retired farmland could be incorporated into the floodway by removing the levee. This could potentially mitigate downstream flooding.

Site 83 Remnant Bosque and Rincon Siphon

The Remnant Bosque and Rincon Siphon is a 92-acre combined site. The remnant bosque area is located on the north bank of the river from mile 82 to 84 and abuts BLM property.

The Rincon Siphon portion of the site includes Garcia Arroyo on the eastern side of the river upstream of the Rincon Siphon at mile 82. A groin was installed on the west bank to provide aquatic habitat. The arroyo deposits sediments in the river upstream of the bridge. The siphon is protected by a grade control dam consisting of boulders that create low velocity backwater to minimize erosion of the siphon bedding material. The high backwater elevation creates wetlands habitat in the floodway near the bridge. The land elevation on either side of Garcia Arroyo outside the right-of-way is also relatively low.

Proposed Actions

The area upstream of the Rincon Siphon within the floodway should be left unmowed to encourage growth of wetlands vegetation. The levees on the east side of the river upstream from the bridge could be set back to incorporate the low-lying area into the floodway and increase the wetlands habitat. A 109-acre tract of land would be required for the levee setback.

The remnant bosque could be converted into a no-mow zone to allow native riparian vegetation to become established to better transition the BLM land with the river corridor. Drain waters could be used to enhance wetlands habitat on the south side of the river.

Site 80 Angostura Arroyo

Angostura Arroyo enters the south side of the river at mile 80. The arroyo has a drainage area of 8.9 miles and extends for 9.6 miles north from its headwaters to the river. It is designated as a Class III arroyo and has no sediment control dam.

Proposed Actions

Erosion control in the Angostura Arroyo watershed would reduce sediment load to the river at this point. This could include erosion control blankets on the arroyo banks, establishing vegetative cover on erosion-prone land, or other watershed management measures. A sediment control dam on the arroyo would also reduce the impact of floodwaters.

On the northern bank of the river from mile 80 to mile 81 is a large uncultivated tract that could be used for a levee setback site. The area could be planted with native vegetation to provide habitat that would be near the USIBWC right-of-way along Angostura Arroyo.

Site 78.5 Rincon Arroyo and Reed Arroyo

Rincon Arroyo

Rincon Arroyo enters the river from the north bank near mile 78.5. The arroyo has a watershed of 124.7 square miles and extends for 30 miles to the north with numerous tributaries. This is the largest arroyo entering the river with no sediment control dam. An island created by the sediment deposits is heavily vegetated with willow. Russian olive and tamarisk dominate the bank in a narrow strip 20 to 40 feet wide. An embayment mitigation site on the north bank has become filled with silt but supports emergent vegetation, including cattail and sedges.

Reed Arroyo

Reed Arroyo enters the river on the south bank at mile 78. The arroyo has a watershed of 9.6 square miles and is 6.6 miles long. No sediment control dams are located on the arroyo. The arroyo channel contains cattail with limited tamarisk and Russian olive along the bank. Huisach, willow, and aster spinoza are present in isolated areas of the floodplain.

Proposed Actions

Erosion control in the watersheds would reduce the sediment load to the river at this site. This could include erosion control blankets on the arroyo banks, establishing vegetative cover on erosion-prone land or other watershed management measures. Sediment control dams on the arroyos would also reduce the impact of floodwaters.

Site 76 Bignell Arroyo

Bignell Arroyo enters the river on the south bank near mile 76. The arroyo extends for 7.6 miles from the river and is not controlled by a sediment dam. Woody vegetation (tamarix and willow) is found in drains and along riverbanks. The site includes 113 acres of riparian and upland habitat.

Proposed Actions

Erosion control in the watershed would reduce the sediment load to the river. This could include erosion control blankets on the arroyo banks, establishing vegetative cover on erosion-prone land or other watershed management measures. A sediment control dam on the arroyo would also reduce the impact of floodwaters.

Native vegetation could be established adjacent to the mouth of the arroyo to provide habitat and connect the river with undeveloped lands to the south.

Establishing a no-mow zone along the site with tamarix control is suggested to improve the riparian habitat. In addition, the west side of the site provides a good location for large wetland enhancement and creation (17 acres) along west side.

6.3.4 Seldon Canyon River Management Unit

Site 69 Dead Mans Curve

Seldon Canyon has very limited USIBWC right-of-way for riparian actions.

Proposed Actions

A 59-acre low-lying private tract on the west side of the river at mile 69 in Seldon Canyon is a potential land acquisition site for creating wetlands habitat. The site is partially cultivated but is connected to undeveloped uplands on both sides of the river. A similar-sized tract on the east side of the river is undeveloped and is a potential wetlands or riparian habitat site. This site is owned by New Mexico State University (NMSU).

Site 67 Broad Canyon

Broad Canyon enters the river near mile 67 after discharging from an NRCS dam. USIBWC right-of-way includes a small area at the mouth of the canyon. The opposite bank is owned by NMSU. Private rangeland extends from the right-of-way to state-owned land along the channel from the dam. The private land is severely over-grazed and devoid of ground cover. Huisache and mesquite shrubs dominate the area. The riverbank is very heavily infested with tamarisk. The area hosts some of the most mature and dense tamarisk in the project area. Overhanging tamarisk limbs provide shading and structure along the shoreline.

Proposed Actions

A riparian and wetland habitat site could be established at this point by utilizing the mouth of the Broad Canyon channel and the riverbank. Significant invasive species control would be required to establish native bosque. Some of the area could best be managed for endangered species. Additional actions include purchasing the privately held rangeland adjacent to the right-of-way (47 acres) and restoring native upland species potentially reducing erosion and sediment loads entering the river. Management could include limiting invasive species control to newly acquired property and allowing the "old growth" tamarix to remain as a stream side erosion control.

Site 62 Leasburg Dam

Leasburg Dam at mile 62 includes a tract of land owned by the Bureau of Reclamation on the west side of the river upstream of the dam. The tract is heavily wooded. Adjacent to the dam on the east side of the river is property owned by NMSU. A state park has also been developed in the area. The dam accumulates sediment and the upstream area is periodically dredged by the Bureau of Reclamation.

Wetlands habitat and flooded bosque are present upstream of the dam due to high water levels. Juncus and tamarisk are common on the eastern riverbank. Downstream of the dam, a large vegetated island provides a backwater habitat near the western shore.

The island is heavily infested with tamarix of multiple age classes, possibly providing suitable habitat for the endangered Southwestern willow flycatcher.

Proposed Actions

Actions include enhancing four acres of riparian woodland in conjunction with parkland improvements. Leasburg Dam has limited USIBWC right-of-way with multiple use actions a good management option.

6.3.5 Upper Mesilla Valley River Management Unit

Site 57.5 Westside

Westside provides a unique opportunity to improve the river corridor and uplands connectivity by altering grazing and mowing practices. The west side of the river contains several remnant bosques, mostly dominated by tamarix but with occasional mature cottonwoods and cottonwood snags. Deer were frequently observed along the shoreline. The limited access to the area (west side) adds to the appeal of enhancing the Westside site as a native bosque habitat.

Proposed Actions

The primary actions include reduced mowing, elimination of grazing and extensive tamarix control over a 160-acre of right-of-way to improve the river-uplands connectivity. Pole planting should be conducted after tamarix removal on the west and east side of the river. Adding an additional 4 acres of aquatic improvements will increase overall diversity of the site.

Site 56.5 Levee Setback

The site includes 36 acres on the east side of the right-of-way and 25 acres outside the right-of-way. The area currently has low wildlife value and could be enhanced through a combination of planting and wetlands development. A 500-foot wide cultivated field on the east side of the river at mile 57 is a potential site to set back the levee to provide additional floodway area that could be planted with native vegetation.

Proposed Actions

The tract outside the right-of-way was at one time owned by the State of New Mexico and contained a slough. The land surface elevation at this location could be modified to achieve wetlands and / or riparian communities. Purchase of the land and a levee setback have been identified as the major actions.

Site 55.5 Seldon Drain

Seldon Drain enters the east side of the river near mile 56.

Proposed Actions

The drain could be used to create an embayment cut into the right-of-way. This would create low-velocity water for aquatic habitat and wetlands vegetation. The opposite bank is undeveloped and therefore provides a corridor for wildlife to access the enhancement. A similar feature could be constructed at Wasteway No. 2, which is located near mile 55.5. The total area is 11 acres.

<u>Site 54.5 Channel Cut</u>

Between mile 54 and 55, the river channel was straightened during the Project construction. The site includes several large areas on each side of the river totaling over 340 acres. The riparian and upland sites are currently mowed but provide good opportunities for riparian enhancements.

Proposed Actions

The previous meander on the western side of the right-of-way could be restored to create an island with additional riparian and wetlands habitat. The western side of the right-of-way is undeveloped and provides a corridor for wildlife to access the river. Twenty-three acres of aquatic enhancements are identified within the site. Combining aquatic enhancements with extensive riparian actions could produce a natural assemblage in one of the largest sites in the project area.

<u>Site 52.5 Wasteway No. 2A</u>

Wasteway No. 2A is a 30-acre site entering the river near mile 52.5. Between mile 51.5 and 52.5 the right-of-way on the east side of the river is about 500 feet wide and includes some pole plantings.

Proposed Actions

The mouth of the wasteway could be converted into an embayment to provide wetlands and aquatic habitat. The right-of-way could be planted with additional native vegetation and designated a no-mow zone. Tamarisk control within the no-mow zone would be needed.

6.3.6 Las Cruces River Management Unit

<u>Site 50 Wasteway No. 5</u>

Wasteway No. 5 is a 30-acre site located on the eastern bank of the river at mile 50. The mouth of the wasteway could be converted into an embayment to provide wetlands and aquatic habitat. Cluster plantings of cottonwoods have become established on the western side of the river. The site is within a green zone and includes two wasteways and a pole planting area.

Proposed Actions

The cottonwood plantings should be expanded and additional native vegetation established. The point bar at mile 50.5 can be regraded to slope more gradually to the water's edge for additional wetlands habitat. Managing the site in conjunction with Las Cruces parks and recreation would maximize the benefit of enhancement actions. The Las Cruces sites provide good multiple use management opportunities.

Site 48.5 Wasteway No. 39

Wasteway No. 39 is a 42-acre site, which flows from the Picacho Lateral to the west bank of the river near mile 49.

Proposed Actions

The mouth of the wasteway could be converted into an embayment to provide wetlands and aquatic habitat. Plantings on the right-of-way at mile 48.5 can be expanded to provide additional native vegetation for uplands and riparian habitat. Managing the site in conjunction with Las Cruces parks would maximize the benefit of enhancement actions.

Site 48.5 Wasteway No. 39

Wasteway No. 39 is a 42-acre site. The site is within the right-of-way and includes areas on both sides of the river. The areas are currently mowed. Residential and commercial development exists east of the right-of-way and agricultural land uses are adjacent to the western edge of the right-of-way.

Proposed Actions

An embayment at this location would create additional aquatic habitat. In addition, the relatively wide right-of-way at this location allows space for planting of cottonwoods and other native vegetation near the embayment for additional habitat.

Site 47.5 Wasteway No. 8

Wasteway No. 8 is a 26-acre site entering the east bank of the river at mile 47.5. The site is currently mowed and bounded by a levee. Agricultural land is east of the levee.

Proposed Actions

An embayment at this location would create additional aquatic habitat. In addition, the relatively wide right-of-way at this location allows space for planting of cottonwoods and other native vegetation near the embayment for additional habitat.

Site 46.5 Wasteway No. 39A

Wasteway No. 39A is a 23-acre site entering the east bank of the river at mile 46.5.

Proposed Actions

An embayment at this location would create additional aquatic habitat. The right-of-way is relatively narrow and does not provide much room for additional vegetation.

6.3.7 Lower Mesilla Valley River Management Unit

Site 42.5 Clark Lateral and Alamo Drain

The USIBWC right-of-way extends past the levee to the Clark Lateral on the east side of the river at mile 43. Grass and shrubs dominate the area due to mowing, although some mature acacia and cottonwoods are present at the south end. Wetlands vegetation includes *Scirpis americanus* and *Disticlis spp* (salt bermuda). Little non-native vegetation was noted.

Proposed Actions

The area outside the levee could be used to establish wetlands habitat. Soil samples taken during irrigation season indicated that soil moisture was high near the surface of the ground. Vegetation in this area would not impact flood flows. Inside the levee, the right-of-way is relatively wide indicating that native vegetation could be established without restricting flood flows. A river channel originally flowed through this area, and this flow could be reestablished by excavating the old channel. An island would be created to provide riparian habitat and the slow velocity water in the excavated channel would provide aquatic habitat.

Site 41.5 NMGF Bosque (Picacho Bosque)

A privately owned tract of land on the west side of the river near mile 41.5 has been identified by SWEC as the potential site of Bosque Park. The presence of an old channel through the tract is evident from vegetation and from historical maps. Undeveloped land south of this tract is owned by NMGF, locally known as Picacho Bosque.

Proposed Actions

Reportedly, the EBID has verbally agreed to allow water from the nearby Picacho Drain to be diverted through a meandering course and out of the levee. Riparian and wetlands vegetation would be established in the park.

In coordination with this concept, the west levee could be set back to allow the floodway to encompass the park. This would provide additional floodway capacity to permit native vegetation to grow on both sides of the river. Water from Picacho Drain could also be allowed to flow into the NMGF property, creating additional riparian habitat.

Site 39.5 Mesilla Dam

Mesilla Dam is a small 1-acre tract located at mile 39.5 but includes almost 15 acres of potential aquatic habitat.

Proposed Actions

The primary enhancement actions are for improving aquatic habitat. The key to enhancements is to provide a diversity of aquatic habitat during high flow conditions such as still backwater areas. Improvements include creating a stepped channel leading from the dam spillway (fish passage) that would connect approximately 10 acres of low-velocity water upstream of the dam.

Site 34 Pole Planting Area

The 28-acre site includes previous pole planting areas and an unnamed drain. Cottonwoods have become established in this area through pole plantings.

Proposed Actions

Primary actions include additional pole plantings, expansion of a no-mow zone through the 28-acre site and tamarix control. An embayment is proposed at the mouth of the drain. The partial success of previous pole planting efforts support continued planting efforts.

Site 29.5 Wasteway 18

Wasteway 18 includes two locations; a right-of-way section (45 acres) and private lands outside the right-of-way (25 acres). Wasteway 18 enters the river from the east at mile 29. Upstream from the wasteway at mile 29.5 an oxbow was cut off during the Project construction. Locations within the right-of-way are typical of the lower Mesilla Valley floodway; heavily maintained with little species diversity. A narrow woody margin (tamarisk/willow) is found along the riverbank.

Proposed Actions

The major action includes a levee setback and land acquisition. The levee setback will provide a means to incorporate additional floodplain, which previously contained the oxbow location. Options include creating an island with aquatic, wetland, and riparian habitat and constructing an embayment at the mouth of the wasteway for aquatic habitat.

Site 28 Old Channel

The Old Channel site is composed of three areas. Two are within the right-of-way (45 acres) and one is outside the right-of-way (36 acres) containing an oxbow eliminated from the west side of the river during Project construction. The oxbow was located at mile 28, north of the Vado Bridge, and is currently in agricultural production. The locations within the right-of-way are typical of the Lower Mesilla Valley floodway, heavily maintained with little species diversity. A narrow woody margin (tamarisk/willow) is found along the riverbank. The enhancement locations within the right-of-way were selected to complement the oxbow location and because they add or connect other desirable locations outside the right-of-way to the river channel. The value of the right-of-way locations is considerably less if not augmented by the oxbow reconstruction. Cumulative benefits are a factor throughout much of the site

Proposed Actions

The major action includes a levee setback and land acquisition. This levee setback as with others identified within the Project, are not constructed with flood control as the primary function, but rather as a means to incorporate additional floodplain, which previously contained meanders or oxbows. Including meanders within the floodplain provides additional high quality areas for bosques or wetlands to become established. The meanders are typically at lower elevations than surrounding floodplain and are more readily flooded, either through active or passive means. Highly selective widening of the floodplain by levee setbacks will not restore the "dynamic equilibrium" of the river, but will provide for quality habitat if managed properly.

Site 26.5 Del Rio Drain

The Del Rio Drain enters the east side of the river at mile 27. The mouth of the drain is a small embayment with wetlands vegetation, including reeds and willows lining its banks. A peninsula created by the embayment is made up of sandy soil and is about five feet above the water surface.

Proposed Actions

Additional native vegetation could be established at the point where the Del Rio Drain enters the river. An oxbow was also eliminated from the west side of the river at mile 27 during the Project construction and could be restored to create additional habitat. The land would need to be purchased from private landowners. A levee setback would provide flood capacity to offset the effect of additional vegetation.

Site 25.5 Wasteway 19

Wasteway 19 is a 28-acre site located on the eastern bank at mile 26.

Proposed Actions

Drains provide opportunities for riparian and wetland related actions due to the ready source of water. Aquatic actions such as embayments can be implemented around drains and wasteways. An embayment is proposed to be constructed at the mouth of the wasteway for aquatic habitat.

Site 22 Wasteway 31 and Wasteway 20

This small site is comprised of 12 acres situated around several wasteways. Three drains enter the river within 1,500 feet of each other near mile 22. Mesa Drain and Wasteway 31 are on the western side, and Wasteway 20 is on the eastern side.

Proposed Actions

A large embayment or widening of the river can be constructed to receive the two drains on the west side. A smaller embayment constructed on the east side would receive flow from Wasteway 20 and provide aquatic and wetlands habitat.

6.3.8 El Paso River Management Unit

Site 19.5 Jimenez and Three Saints West Lateral Drains and Wetland Compartments

Jimenez and Three Saints West Lateral Drains and wetland compartments are composed of five separate locations. The Jimenez and Three Saints West Lateral Drains enter at mile 19.5 directly opposite each other. The wetland compartments are north of the confluence of the drains. The wetlands compartments are found in the right-of-way where the water table is very near the floodway surface during high flows. Wetland vegetation was observed within the lower areas of the compartments.

Proposed Actions

The drains include aquatic enhancements such as embayments. Drains and wasteways are some of the more cost-effective areas for enhancement. Existing areas within the floodway are potential locations for constructing moist soil impoundments. Lateral ridges running perpendicular to the river are present in the floodway because of river training structures installed to maintain the channel alignment. Compartments can be created using the ridges as the sides and constructing an earthen berm between the ridges parallel to the channel. Achieving proper water depth would be accomplished using a combination of excavation and/or pumping from the river. It is likely that the seed bank is present for wetland species and creation of wetlands could be a rapid process given proper watering and dewatering regimes within the compartments.

Site 16 East Drain / Border Steel

East Drain / Border Steel is composed of three locations, two within the right-of-way (20 acres) and a tract of land outside the right-of-way that contains a drain that enters the east side of the river south of Border Steel near mile 16.5. A former meander is partially contained within the right-of-way. The low-lying area within the meander supports wetlands vegetation.

Proposed Actions

Enhancement actions emphasize the riparian habitat through cessation of mowing and pole planting within the meander inside and outside the right-of-way. In addition, the conditions are favorable for expansion of wetlands. Aquatic actions include an embayment constructed at the mouth of the wasteway. Upstream and adjacent to Border Steel is an additional low-lying area that supports wetland vegetation that can also be enhanced.

Site 10 Wasteway 34

Wasteway 34 is a small site of less than 2 acres that enters the western side of the river near mile 10.5. The wasteway is located in a part of the right-of-way that abuts a future park next to an elementary school. The value of including small sites is that environmental action can be conducted on a smaller scale than several of the previously mentioned sites can. Small sites provide a cost effective test area for enhancements and can be spread throughout the Project to evaluate various techniques. Most of the small sites are associated with drains.

Proposed Actions

The proposed enhancement action is tree planting within the right-of-way. Wasteways provide opportunities for riparian and wetland related actions. Wasteways provide a ready source of water and can be modified to promote sheet flow over the floodway before entering the river. Weir structures and earthworks can be used to create moist soil conditions conducive to wetland development.

Site 9 Wasteway 35

Wasteway 35 enters the western side of the river near mile 9. The wasteway is located in part of the right-of-way that abuts a future park planned by the city of El Paso. Pole plantings have been attempted in this area.

Proposed Actions

Actions include construction of an embayment at the mouth of the wasteway and pole plantings in the right-of-way near the future park. Wasteways provide opportunities for riparian and wetland related actions. Wasteways provide a ready source of water and can be modified to promote sheet flow over the floodway before entering the river.

Site 7 Nemexas Drain

The Nemexas Drain site includes the Nemexas Drain (22 acres) and the east right-of-way tract (20 acres) directly across from the drain. The Nemexas Drain and three southerly sites, Sunland Park West Bank, Cottonwood Grove, and Anapra Bridge, are parts of a grouping of sites, which can potentially be managed as a single project for riparian enhancement and multi-use activities. The Nemexas Drain enters the river at mile 7 from the west. The USIBWC right-of-way is heavily vegetated with mature tamarisk. Upstream of the drain on the east bank is an area where the USIBWC right-of-way widens that has been planted with cottonwoods. Behind the levee, the land is developed for residential use. The site contains some of the oldest tamarisk south of the Vinton Cutoff. The area is classed as riparian woodland due to the structure and height of vegetation.

Proposed Actions

An embayment at the drain would provide aquatic habitat that would be linked with the heavily vegetated right-of-way and pole plantings on the east bank. The majority of actions emphasize riparian enhancement through reduced maintenance and tamarisk control. The potential of the site can be seen in the Cottonwood Grove site where similar conditions and less mowing have produced mixed age cottonwood stands.

Site 5 Sunland Park West Bank

Sunland Park West Bank is composed of three right-of-way tracts with a total of 76 acres. Residential property abuts the right-of-way on a bluff about 50 feet above the water surface. General rubbish and household debris are spilling down the bluff from the residential property.

Proposed Actions

The right-of-way near the water's edge could be excavated to create a land surface that enters the river with a gradual slope to provide wetland habitat. Native upland vegetation (approximately 10 acres) could be planted away from the water up to the base of the bluff. Tamarisk control is recommended for the site. The potential of the site can be seen in the Cottonwood Grove site where similar conditions and less mowing have produced mixed age cottonwood stands.

Site 4 Cottonwood Grove

The site is composed of three locations (48 acres). A successful no-mowing area on the north side of the river at mile 4 has allowed a cottonwood grove to become established. Cottonwoods have become established primarily through root suckers originating from only a few individual trees. Distinct groves of mixed age cottonwood are found in proximity to declining older trees. Willow and tamarisk line the riverbanks. The water table is near the floodway surface in much of the area during high flow periods. Wetland vegetation is scattered throughout the site. This area is managed by the El Paso Parks Department.

Proposed Actions

The site has the potential to mature to a cottonwood bosque. The presence of mixed aged cottonwoods is an excellent sign that conditions are favorable for continued colonization and establishment of a cottonwood/willow community. Management efforts should concentrate on tamarisk control and continued mowing restrictions. In addition, restrictions on motorized vehicles on the floodway should be enforced. The combination of bosque and multi-use parkland creates one of the best opportunities for river enhancement and public participation. Pedestrian access from both ends with walkways and trails would make the park more useful. Fencing to prevent trash disposal may also be needed.

<u>Site 3 Anapra Bridge</u>

The Anapra Bridge site includes land within the right-of-way (30 acres) on the north and south banks of the river. Both locations have potential for riparian enhancement of the floodway and conversion of existing upland habitat to one with more native species. The south bank of the river at mile 3 has an undeveloped 34-acre tract between the right-of-way and the base of a bluff.

Proposed Actions

Primary actions include enhancing upland habitat adjacent to the bluffs and enhancing riparian habitat outside the current right-of-way. Enhancement potential of riparian vegetation in the existing right-of-way is minimal due to potential flood control issues. However, no-mow zones with tamarisk control would add vegetative diversity to the floodway.

6.4 Significant Site Groupings (Beads)

Several river restoration projects have incorporated the concept of habitat beads for guiding site selection and ultimately managing the sites. Habitat beads are a series of key habitat areas along a stretch of river, much like a string of beads. The beads are managed in an attempt to restore some semblance of the natural features (Rasmussen, undated). Beads are composed of groups of sites which, when analyzed together, provide a quality and quanity of various habitats. The concept can be applied to the Project to prioritize sites. Sites which are incorporated within a bead would potentially have greater value than if managed separately. Beads can be viewed as restoration projects within the overall Project area. Certainly there is value in managing sites outside of a bead; for instance, creating small wetlands adjacent to drains has localized benefit and, because of the relatively small cost compared to a bead, could be more easily developed.

Six clusters of sites (beads) were identified of which three are located in the Upper Rincon Valley river management unit, and one each in the Upper Mesilla Valley, Lower Mesilla Valley, and El Paso river mangement units. Table 6.10 lists each bead.

Table 6.10 Habitat Beads

Bead	Sites	Area (acres)
Upper Rincon	Holguin Arroyo, Montoya Arroyo, Oxbow Restoration Site, Tipton Arroyo, Trujillo Arroyo	303
Jaralosa	Green/Tierra Blanco, Jaralosa Arroyo, Sibley Arroyo Point Bar	1,291
Crow Canyon	Crow Canyon, Hatch Siphon, Wasteway No. 35, Yeso Arroyo	1,724
Upper Mesilla	Channel Cut, Levee Setback, Seldon Drain, and Wasteway No. 2A.	421
Black Mesa	Clark Lateral, NMGF Bosque (Picacho Bosque)	276
Sunland Park	Anapra Bridge, Cottonwood Grove, Nemexas Drain, Sunland Park	233

SECTION 7
DESCRIPTION OF ALTERNATIVES

A total of five alternatives were considered to evaluate the environmental impact of the USIBWC Canalization Project. The alternatives are based on maintaining the USIBWC's mission of flood control and water deliveries while providing a feasible level of environmental enhancement and restoration. The process of formulating the alternatives is described in Section 4.

Alternatives 1 through 3 limit the environmental actions to the current USIBWC right-of-way. Alternatives 4 and 5 extend enhancement actions beyond the existing right-of-way through land purchases, leases, easements, cooperative agreements, and other mechanisms. Table 7.1 lists potential enhancement actions and selected sites for each alternative. The alternatives are cumulative in that each alternative includes all those actions from previous alternatives plus additional enhancements. Table 7.1 also shows the totals for each action and units used to quantify the action.

Figure 3.1 in Section 3 shows the location of the sites, and Figures A-1 through A-15 in Appendix A show the areas designated for each site. Appendix E is an enlargement of Figure 3.1.

7.1 ALTERNATIVE 1 - CURRENT OPERATION (NO ACTION)

The no-action alternative consists of continuing the operation and maintenance activities currently practiced by USIBWC. Those activities, described in Section 3, are directed toward the objectives of flood protection and water delivery.

- Mow floodway and levees;
- Place erosion controls in channel;
- Repair levees;
- Repair gates on drains;
- Lease right-of-way land;
- Remove sediment from channel at arroyos; and
- Maintain NRCS dams.

Flood protection provided by the existing levee system would be maintained, but not upgraded. Ongoing sediment removal would be periodically required at arroyo mouths, diversion dams, and in other portions of the main channel. Existing mitigation sites would be maintained and monitored but not increased.

Table 7.2 shows the habitat area for all potential enhancement sites in Alternative 1 for each river management unit. The total habitat units are also shown for each management unit.

Table 7.1 Potential Enhancement Actions and Selected Sites for Each Alternative

		Upper Rincon										Lower Rincon									Seldon Canyon			Upper Mesilla				
		Oxbow Restoration	Tipton Arroyo	Trujillo Arroyo	Montoya Arroyo	Holguin Arroyo	Green / Tierra Blanca Arroyos	Sibley Arroyo	Jaralosa Arroyo / Remnant Bosque	Yeso Arroyo	Crow Canyon / Channel Cut	Hatch Siphon	Wetlands Unit A	Wetlands Unit B	Garfield Drain	Placitas Arroyo	Remnant Bosque / Rincon Siphon	Angostura Arroyo	Rincon / Reed Arroyos	Bignell Arroyo.	Dead Mans Curve	Broad Canyon	Leasburg Dam	West Side	Levee Setback	Seldon Drain	Channel Cut	Wasteway No. 2A.
PROJECT FUNCTIONALITY (USIBWC MISSION)	**Unit**	**104.5**	**104**	**103**	**101.5**	**101**	**99.5**	**98**	**96.5**	**93.5**	**92**	**90**	**89**	**87**	**86**	**84.5**	**83**	**80**	**78**	**76**	**69**	**67**	**62**	**57.5**	**56.5**	**55.5**	**54.5**	**52**
Raise levees/add flood control structures	mile																1.1	0.9	0.4	0.7	5.8			0.4	0.9			0.3
Modify dredging at arroyos	event		1	1	1		2	1		2						1			1									
Modify spoil disposal locations/practices	1000 yd3		20	20	20		40	20		40						20			20									
Acquire flood easements and set back levees	acre																88	21						0	0			
Reduce dredging of pilot channel	1000 yd3																				100	100	250					
Reduce runoff entering river during floods																												
Erosion control/dams in tributaries	dam			1	1		1	1		1						1			2	1		1						
AQUATIC/RIPARIAN HABITAT ENHANCEMENTS																												
Mouth of Arroyos/Canyons																												
Retain/expand existing groin structures	unit			1	1	1				2						1			1									
Retain/expand existing weirs, embayments	unit			1	1		1	1											1									
Additional groin locations	unit	1	1			1	2		2		2				1			1						2	1	1		
Additional weir/embayment locations	unit	1	1		2	2	2	2	3	2	2				1			1	1	1				2	1			1
Create/expand wetlands	acre	1	1	2	2	2	2	2	5	2	2	2	10	10		2	2		2	12				4	1	2		
Widen Channel	acre		2	5	2					2	5																	
Water Diversion Structures & Siphons																												
Create white-water fish habitat	acre											2					1											
Provide back-water habitat	acre																1											
Wasteways/Drains																												
Reduced maintenance	acre								2	1					10											5		1
Enhance wetlands	acre				2				2	1					4	2										1		2
Riparian Vegetation Sites																												
Expand remnant bosques/riparian veg.	acre		8		5		3	0	50	20	30	4			5	10	10	10	5	5	0			60			20	
Control invasive vegetation (salt cedar)	acre	9	8	29	23	6	24	21	60	86	105	11	0	0	20	30	20	40	45	45	0	0	5	40	10	5	97	5
Planting sites within ROW	acre		0	10	5	20	20	10	20		20						10								10		10	1
Planting sites outside ROW	acre			10	20											20	20	10			5	10		0	0			
Land purchases for habitat	acre			74	55				355							132	109	43			59	47		0	25			
IBWC Land Management																												
Retain existing no-mow zones	acre	15	15	44																			5					
Additional no-mow zones (exluding leases)	acre				0				0	30		15			15	40	40	50	50	50					0			5
Discontinue leases	acre				40	28	50	33	150	90	200													100	20		150	
RESTORATION OF FLUVIAL PROCESSES																												
Old Channels & Oxbows																												
Channel splits ROW	acre	6			5		3	2	20	10	40																23	
Embayments within ROW	unit					2				2																		
Levee setback,	acre			0.75																								
Control invasive vegetation (salt cedar) outsid	acre			30	35	0	0	0	315	0	0	0	0	0	0	112	89	33	0	0	34	37	0	0	20	0	0	0
New meanders outside ROW	acre			0																					5	0		
Bank overflow by shave downs	acre		5		5		8	5																			10	
Create/expand wetlands outside ROW	acre				20				40												20				5	0		
Flow Regime Modification																												
Allow seasonal peak flows		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1																	
Establish minimum in-stream flows		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MULTIPURPOSE PROJECT MANAGEMENT																												
Add recreational areas	acre																						4					
Interagency cooperation agreements																			1	1	1	1	1					
Improve water quality, water conservation	acre																											

Legend

Alternative 1
Alternative 2
Alternative 3
Alternative 4
Alternative 5

Table 7.1 Potential Enhancement Actions and Selected Sites for Each Alternative

		Las Cruces				Lower Mesilla									El Paso									
		Wasteway No. 5	Wasteway No. 39	Wasteway No. 8	Wasteway No. 39A.	Clark Lateral	NMGF Bosque	Mesilla Dam	Pole Planting Area	Wasteway 18	Old Channel	Del Rio Drain	Wasteway 19	Wasteway 31 and Wasteway 20.	Jimenez & Three Saints West Drains.	East Drain / Border Steel.	Wasteway 34	Wasteway 35	Nemexas Drain	Sundland Park West Bank	Cottonwood Grove	Anapra Bridge		
PROJECT FUNCTIONALITY (USIBWC MISSION)	**Unit**	**50**	**48.5**	**47.5**	**46.6**	**42.5**	**41.5**	**39.5**	**34**	**29.5**	**28**	**26.5**	**25.5**	**22**	**19.5**	**16**	**10**	**9**	**7**	**5**	**4**	**3**	**Total**	**Unit**
Raise levees/add flood control structures	mile	1.4	0.4	2.1	0.9	2.1	5.3	1.0	0.4		1.4	1.3	0.7	5.0	4.9	6.8	8.3	9.3	2.0	2.7	2.5	0.9	69.9	mile
Modify dredging at arroyos	event																						10	event
Modify spoil disposal locations/practices	1000 yd3																						200	1000 yd3
Acquire flood easements and set back levees	acre										24												133	acre
Reduce dredging of pilot channel	1000 yd3																						450	1000 yd3
Reduce runoff entering river during floods																							0	
Erosion control/dams in tributaries	dam																						10	dam
AQUATIC/RIPARIAN HABITAT ENHANCEMENTS																								
Mouth of Arroyos/Canyons																								
Retain/expand existing groin structures	unit																						7	unit
Retain/expand existing weirs, embayments	unit																						5	unit
Additional groin locations	unit						2												1				18	unit
Additional weir/embayment locations	unit	1	1	2	1		2		1						2	0	1	1	1				38	unit
Create/expand wetlands	acre					10	5						3	5	1	0			1				93	acre
Widen Channel	acre																						16	acre
Water Diversion Structures & Siphons																								
Create white-water fish habitat	acre																						3	acre
Provide back-water habitat	acre							10															11	acre
Wasteways/Drains																								
Reduced maintenance	acre	1	1	15			40	0		5			8	5	5	2	0	5	4	44			154	acre
Enhance wetlands	acre	2	2	3	1		4			2	2		1	1	1	2	0	1					36	acre
Riparian Vegetation Sites																								
Expand remnant bosques/riparian veg.	acre					0		0	1										0		3		249	acre
Control invasive vegetation (salt cedar)	acre	9	11	14	6	15	40	0	4	10	11	15	8	5	35	4	0	13	24	54	30	10	1062	acre
Planting sites within ROW	acre	5	6	5		0			5	5	5	5				10	1	4		10	0		197	acre
Planting sites outside ROW	acre						30			5	5	5				10						10	160	acre
Land purchases for habitat	acre				16		114			24	36	35			0	25						34	1183	acre
IBWC Land Management																								
Retain existing no-mow zones	acre	2	3	4	1																		89	acre
Additional no-mow zones (exluding leases)	acre	11	13	0	5	0			10	10	16	20		0	10	12	1	12	20	20	33		488	acre
Discontinue leases	acre					0									20								881	acre
RESTORATION OF FLUVIAL PROCESSES																								
Old Channels & Oxbows																								
Channel splits ROW	acre					0																	109	acre
Embayments within ROW	unit					0																	4	unit
Levee setback,	acre						1			0.8	1	0.5											4.1	acre
Control invasive vegetation (salt cedar) outsid	acre	0	0	0	16	0	74	0	0	19	31	30	0	0	0	15	0	0	0	0	0	24	914	acre
New meanders outside ROW	acre						20			8	8	6											47	acre
Bank overflow by shave downs	acre																						33	acre
Create/expand wetlands outside ROW	acre						10																95	acre
Flow Regime Modification																								
Allow seasonal peak flows																							1	
Establish minimum in-stream flows		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	
MULTIPURPOSE PROJECT MANAGEMENT																								
Add recreational areas	acre																			10			14	acre
Interagency cooperation agreements																							5	
Improve water quality, water conservation	acre																						0	acre

Legend

Alternative 1
Alternative 2
Alternative 3
Alternative 4
Alternative 5

Table 7.2 Habitat Areas for Alternative 1

Management Unit	Aquatic (acres)	Riparian (acres)	Upland (acres)	Wetlands (acres)	Total (acres)	Habitat Units
Upper Rincon	5	33	2,730	52	2,819	876
Lower Rincon	2	23	557	47	629	210
Seldon Canyon	-	-	-	-	-	-
Upper Mesilla	-	141	400	4	545	200
Las Cruces	-	3	278	7	288	89
Lower Mesilla	-	2	156	6	163	51
El Paso	-	19	256	19	293	98
Total	**6**	**220**	**4,377**	**135**	**4,737**	**1,523**

7.2 ALTERNATIVE 2 - SELECTIVE OPERATION AND MAINTENANCE MODIFICATION

Alternative 2 provides a change in operation and maintenance over the no-action alternative. A number of specific projects were identified for future implementation under Alternative 2. These projects are a continuation of the types of maintenance the USIBWC and other entities historically practice:

- Structural control of erosion at Hatch Siphon and Rincon Siphon;
- Sediment removal from the main channel from Leasburg Bridge to Shalem Bridge;
- Courchesne bridge replacement; and
- Flood protection for East Canutillo.

Riparian habitat at drains will be enhanced by modifying maintenance practices and establishing wetlands.

Aquatic habitat enhancements based on additional in-channel groins and vortex weirs would be constructed. Dredging at the mouths of arroyos would be modified to introduce gravel and cobble deposits to provide aquatic habitat. Dredging in the main channel would be minimized through most of the river and eliminated in Seldon Canyon. Aquatic habitat would also be enhanced at siphons and diversion dams to take advantage of slow-moving backwater. Whitewater habitat downstream of these structures would be enhanced through placement of cobble and boulders.

Table 7.3 shows the habitat area for Alternative 2 for each river management unit. The total habitat units are also shown for each management unit.

Table 7.3 Habitat Areas for Alternative 2

Management Unit	Aquatic (acres)	Riparian (acres)	Upland (acres)	Wetlands (acres)	Total (acres)	Habitat Units
Upper Rincon	7	36	2,722	57	2,821	882
Lower Rincon	6	54	520	53	633	228
Seldon Canyon	-	-	-	-	-	-
Upper Mesilla	-	152	386	7	545	203
Las Cruces	-	75	194	19	288	110
Lower Mesilla	10	32	120	12	173	80
El Paso	-	85	183	26	293	116
Total	**23**	**433**	**4,125**	**174**	**4,753**	**1,619**

7.3 ALTERNATIVE 3 - INTEGRATED USIBWC LAND MANAGEMENT

Integrated USIBWC land management refers to the alternative of maximizing habitat enhancement within the current right-of-way. A total of 48 sites have been designated as locations for various actions designed for aquatic, riparian, and uplands habitat enhancement.

Alternative 3 includes significant excavation of the existing floodway and right-of-way to re-establish flow through river meanders and oxbows eliminated during the Canalization Project. These channels will be excavated with gradually sloping banks to provide aquatic and riparian habitat. Aquatic habitat enhancement will include additional groins and vortex weirs.

Wetlands will be established in the areas where drains enter the floodway by creating moist-soil conditions in beds within the floodway and by excavating embayments open to the main channel where drains enter from outside the floodway.

Riparian habitat enhancement measures will consist of designating additional no-mow zones and limiting leasing of rights-of-way for cattle grazing. A substantial program for control of invasive species, particularly tamarisk, is a critical component of this alternative that includes changes to mowing practices. In conjunction with the no-mow zones, tree-planting initiatives will be initiated to plant up to 100 tree saplings or pole cuttings per acre.

Table 7.4 shows the habitat area for Alternative 3 for each river management unit. The total habitat units are also shown for each management unit.

Table 7.4 Habitat Areas for Alternative 3

Management Unit	Aquatic (acres)	Riparian (acres)	Upland (acres)	Wetlands (acres)	Total (acres)	Habitat Units
Upper Rincon	122	332	2,303	78	2,831	1,304
Lower Rincon	9	238	278	111	636	416
Seldon Canyon	-	-	-	-	-	-
Upper Mesilla	25	198	314	10	547	331
Las Cruces	5	140	114	34	293	200
Lower Mesilla	10	159	(15)	20	173	176
El Paso	4	194	68	32	297	231
Total	**174**	**1,260**	**3,062**	**285**	**4,777**	**2,657**

7.4 ALTERNATIVE 4 - TARGETED RIVER RESTORATION

The targeted river restoration alternative extends environmental actions identified in Alternative 3 to areas outside the right-of-way. Agricultural areas adjacent to the right-of-way were identified for purchase and development of upland habitat. Sites adjacent to the floodplain that are not cultivated were also identified as candidates for purchase to maintain and enhance wetlands or uplands habitat. In addition, old river meanders that once extended outside the right-of-way would be restored by purchasing property, setting back the levee, and excavating the old channel.

Additional excavation will be performed in selected locations at the bank of the existing channel to modify the slope of the bank to a more gradual grade conducive to establishment of emergent vegetation in shallow water. This will increase the effective width of the channel and provide for lower velocity water. This will also provide areas that are subject to intermittent overflows which mimic natural hydraulic patterns and allow vegetation adapted for those patterns to become established.

This alternative also includes establishing wetlands outside the right-of-way using wasteways or drains to provide water prior to returning to the main channel. Property adjacent to drains, particularly areas near the right-of-way with high water table conditions would be purchased to develop the wetlands.

Invasive species control will be expanded to areas outside the right-of-way, particularly on public lands nearest the river. In addition to reducing the proliferation of these species, substantial water losses should be eliminated that may be translated into water allocations from irrigation districts if cooperative agreements can be reached.

Table 7.5 shows the habitat area for Alternative 4 for each river management unit. The total habitat units are also shown for each management unit.

Table 7.5 Habitat Areas for Alternative 4

Management Unit	Aquatic (acres)	Riparian (acres)	Upland (acres)	Wetlands (acres)	Total (acres)	Habitat Units
Upper Rincon	127	385	3,160	138	3,806	1,935
Lower Rincon	9	288	796	111	1,204	771
Seldon Canyon	-	15	177	20	212	138
Upper Mesilla	25	208	304	10	547	337
Las Cruces	25	170	335	44	574	399
Lower Mesilla	32	174	162	20	387	339
El Paso	4	204	151	32	390	283
Total	**221**	**1,443**	**5,085**	**375**	**7,120**	**4,202**

7.5 ALTERNATIVE 5 - MANAGEMENT UNIT MULTIPURPOSE WATERSHED MANAGEMENT

Multipurpose watershed management incorporates all of the environmental actions specified in Alternatives 1 through 4 as well as measures that are implemented outside of the immediate area of the river and right-of-way. Additional erosion control dams on selected arroyos have the dual benefit of reducing the sediment load entering the river and attenuating peak flood flows that must be controlled. Six dams identified during previous studies will be constructed under this alternative. In addition, erosion control measures, where practical in the watershed, are to be implemented.

This alternative also includes flow regime modifications to mimic natural effects of varying flood flows. Releases from Caballo Reservoir will provide an elevated flow of 5,000 cfs for up to three days once a year that is timed to coincide with natural seed release and germination of riparian vegetation.

In addition, minimum instream flows of 200 cfs will be established to ensure hydraulic conditions necessary for survival and reproduction of aquatic species during non-irrigation periods.

In this alternative are other actions that relate to multipurpose use of the USIBWC right-of-way such as for parks and recreation. These actions are not necessarily beneficial to wildlife as habitat. However, areas near urban centers with little opportunity for enhancement or restoration may provide the best use for the area. Both the cities of El Paso and Las Cruces are in the planning phases of developing improvements along sections of the river. Improvements within the USIBWC right-of-way can be incorporated into those projects.

Table 7.6 shows the habitat area for Alternative 5 for each river management unit. The total habitat units are also shown for each management unit.

Table 7.6 Habitat Areas for Alternative 5

Management Unit	Aquatic (acres)	Riparian (acres)	Upland (acres)	Wetlands (acres)	Total (acres)	Habitat Units
Upper Rincon	127	386	3,159	138	3,806	1,936
Lower Rincon	9	290	794	111	1,204	773
Seldon Canyon	-	17	175	20	212	138
Upper Mesilla	25	214	298	10	547	341
Las Cruces	25	170	335	44	574	399
Lower Mesilla	32	174	162	20	387	339
El Paso	4	214	141	32	390	289
Total	**221**	**1,464**	**5,064**	**375**	**7,120**	**4,214**

SECTION 8
PROJECT FUNCTIONALITY EVALUATION

This section details hydraulic modeling of the 100-year flood, including the proposed modifications to approximately 105 miles of the Rio Grande floodway between Percha Dam in New Mexico and the American Diversion Dam in El Paso, Texas. This modeling effort is based on the USACE (Albuquerque District, Hydrology and Hydraulics Section) hydrologic and hydraulic analyses of the current conditions of the same area.

The proposed modifications are presented in Section 7, Description of Alternatives. A comparison between the current conditions and the proposed modifications conditions is described. The levee areas where the 100-year computed water surface elevation encroaches on the design freeboard or overtops the levee are identified. Locations where water velocities may result in levee erosion have also been determined. Based on those results, flood control management actions are included in each alternative.

8.1 Previous USACE Model

The USACE performed the hydrologic and hydraulic analyses of the 100-year flood of approximately 105 miles of the Rio Grande floodway between Percha Dam in New Mexico and the American Diversion Dam in El Paso, Texas. The USACE identified the levee areas where the 100-year computed water surface elevation encroaches the freeboard or overtops the levee (USACE 1996)

8.1.1 Hydrologic Modeling

The USACE generated the 100-year flood discharges at selected locations along the Rio Grande using standard hydrologic procedures and the USACE program HEC-1.

The 100-year storm developed for the study area represented a summer thunderstorm rain flood, which generated the greatest peak flows in the study reach of the river. A storm centered below Caballo Dam was assumed. A 100-year 24-hour duration uniform rainfall of 2.39 inches and a NRCS Type IIa distribution were used. The USACE report provides detailed analysis of the methods used in generating the 100-year flood discharges.

Table 8.1, adopted from the USACE report, lists these peak discharges at the selected stations between Percha Diversion Dam and American Diversion Dam. Figure 8.1 is a graphical representation of these data.

Hydraulic Modeling

The USACE generated the 100-year flood water surface elevations at selected locations along the Rio Grande using standard hydrologic procedures and the USACE computer program HEC-2.

Table 8.1 Design Flows for Irrigation and 100-Year Flood

Miles Above American Dam	Irrigation Design Flow (cfs)	100-yr Flood Flow (cfs)	Miles Above American Dam	Irrigation Design Flow (cfs)	100-yr Flood Flow (cfs)
105.4	2,350	5,000	39.9	1,900	20,000
102.9	2,350	9,100	39.3	1,600	20,100
101.4	2,350	11,300	34.8	1,600	19,600
99.8	2,350	15,600	29.2	1,600	19,200
98.1	2,350	17,600	25.9	1,600	18,700
96.6	2,350	18,700	22.1	1,600	18,300
92.4	2,350	18,900	22.0	1,600	17,900
84.8	2,350	19,100	21.8	1,600	17,700
81.8	2,350	18,300	19.6	1,600	17,600
80.4	2,350	17,700	18.8	1,600	17,400
80.0	2,350	17,800	16.4	1,600	17,100
78.5	2,350	22,400	15.7	1,600	16,800
78.0	2,350	22,500	15.4	1,600	16,600
76.6	2,350	22,000	15.2	1,600	16,500
67.2	2,350	22,400	15.0	1,600	16,400
63.3	2,350	22,400	14.4	1,600	16,300
63.0	2,350	22,200	13.1	1,600	16,100
55.7	1,900	21,300	12.8	1,600	15,900
55.3	1,900	21,000	10.9	1,600	15,000
48.7	1,900	21,300	10.3	1,600	14,800
47.6	1,900	20,500	9.2	1,600	14,600
44.6	1,900	20,100	0.2	1,600	14,300

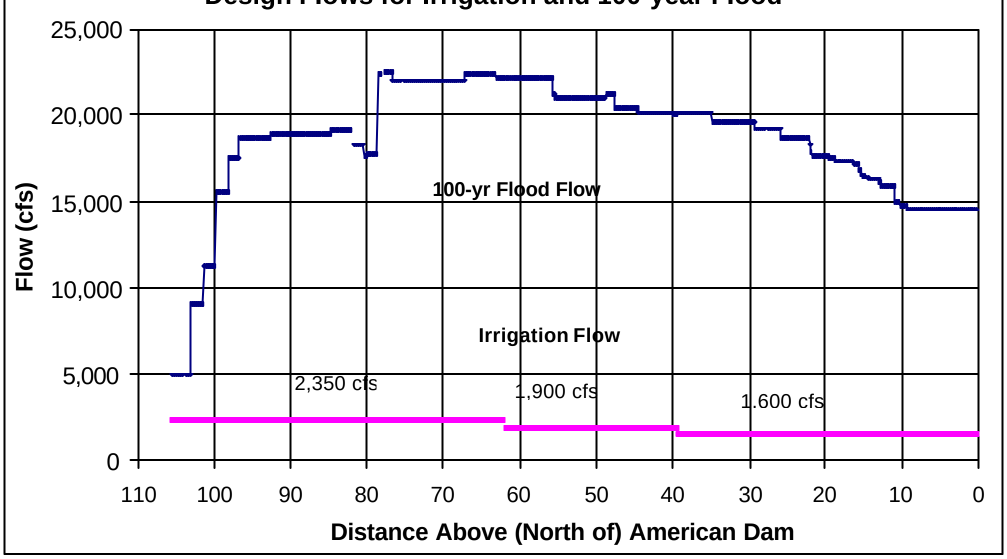


Figure 8.1
Design Flows for Irrigation and 100-year Flood

8.1 Design Flows for Irrigation and 100-Year Flood

8.1.2 Conclusions and Recommendations

In its 1996 report, the USACE recommended the following:

- All levee closure devices should be inspected to insure they would operate correctly in case of flood emergencies. In many cases, several existing closure devices in the study reach have been tampered with and remain permanently open.
- There are five bridges (Brickplant, Courchesne, Borderland, Canutillo, and Tonuco) in which the 100-year flood overtops the roadway elevation. These bridges should be replaced in order to pass the 100-year flood without overtopping. The Tonuco Bridge is an abandoned bridge in the northern reach of the study area and should be removed from the floodway. At this time, the New Mexico Highway Department is only planning to replace the Courchesne Bridge.
- The eastern portion of Canutillo, TX is partly protected from flooding by the Atchison, Topeka, and Santa Fe Railroad embankment which acts as the east levee. The railroad embankment extends for about 5 miles; however, the protection is discontinuous due to uncontrolled openings in the railroad embankment. To successfully contain river flood stages within the floodway, the openings must be eliminated. This can be accomplished on an emergency basis by sandbagging the openings or by building stop-log structures at each opening. Both of these methods require extensive manual labor and coordination during an emergency situation; therefore, the measures are not considered viable solutions unless an extensive flood warning system is implemented.

A recommended structural solution would involve both an earthen levee and concrete floodwall. The floodwall, beginning approximately at river mile 9.9 and extending to river mile 11.3, is necessary due to the constricted flow area that exists; the levee-to-levee width in this reach is only 310 feet to 350 feet. This river section currently represents the hydraulic constriction in the study reach, and the levee-to-levee width cannot be reduced by a new earthen levee section without adversely increasing the water surface elevation upstream. The recommended 7,500-foot-long floodwall would vary in height from 8 to 10 feet, without freeboard, and the structure would be located riverside and immediately adjacent to the Atchison, Topeka, and Santa Fe Railroad embankment (the existing east river levee). To accommodate local drainage, the flood wall must tie into the drainage control structures at appropriate locations. Downstream of river mile 10.8 and upstream of river mile 12.2, the levee-to-levee width expands to approximately 500 feet, allowing the floodwall to transition to an earthen levee.

The west-side levee should incorporate a flood wall extension for the same constricted area (river mile 10.8 to river mile 12.2) to contain the increased water surface elevation resulting from the decrease in effective flow area with the east-side flood wall in place. The west-side flood wall would consist of a vertical wall partially embedded in the existing levee crown. A floodwall extension is possible on the west side because, unlike the east-side levee, the west-side levee does not serve the dual propose of railroad embankment and flood control levee. The existing levee section should be checked for through seepage and underseepage and for embankment and foundation stability. Some methods of controlling seepage and improving embankment stability could eliminate the economic advantage of the flood wall in comparison to an earthen levee enlargement.

8.2 Modeling of Enhancements

This section details the hydraulic modeling of the 100-year flood including the proposed modifications presented in Section 7, Description of Alternatives. The levee areas where the 100-year computed water surface elevation encroaches on the freeboard or overtops the levee are identified.

8.2.1 Revisions to USACE Model Cross Sections

Parsons ES obtained the geometric, the 100-year flood hydrologic, and hydraulic input data used in this modeling analysis from the USACE through the USIBWC. Parsons ES imported the USACE HEC-2 hydraulic input data files that included the cross section geometry into HEC-RAS (Version 2.2). Then the geometric files were modified to accommodate enhancements proposed for the Project. Cross sections representing the proposed Courchesne Bridge were also included in the model.

The cross sections were modified to include the set back of levees at 3 sites that include property outside the USIBWC right-of-way. These sites contained river channels or other features prior to the Canalization Project construction that make them attractive for environmental enhancement. A total of 115 acres were encompassed by the setbacks modeled. Although areas outside the right-of-way are an element of Alternative 4, the modeling results presented also apply to Alternatives 2 and 3 in terms of identifying the need for levee reconstruction. This is considered valid because the water elevations are not greatly affected between alternatives by the limited levee setbacks considered.

8.2.3 Channel Roughness Coefficient

The HEC-RAS model incorporates a channel roughness coefficient (Manning's "n" value) of 0.02 and overbank roughness coefficients that range from 0.03 to 0.15. The "n" values for the channel and overbank areas subject to enhancements were determined based on land cover (Chow 1959). Table 8.2 displays the values and conditions of Manning's "n" used for this modeling effort.

Table 8.2 Manning's "n" Values

Land Type	Manning's "n" Value
Rio Grande channel	0.02
Overbank Areas	
Mowed brush	0.03
Agriculture	0.04
Wetlands	0.05
Shrubs	0.10
Trees	0.15

Table C.1 in Appendix C shows the selected "n" values used in this modeling effort for the modified cross sections. Table C.1 also lists the "n" values for the left bank, channel, and right bank used by the USACE in its HEC-2 model and those used in the HEC-RAS model. Table C.1 lists whether or not changes in the cross sections occurred.

8.2.4 Model Results for Enhancements and Conclusion

Since design and construction data for the levees are lacking, the structural integrity of the entire system is uncertain. However, portions of the levees that are deficient in elevation relative to a predicted water surface level were identified. In addition, portions of the levees subject to excessive erosive forces due to high water velocities were identified.

Figure 8.2 shows a schematic representation of the model results with 0.1-mile sections color coded where potential problems exist. Results of the HEC-RAS model for the 100-year flood conditions are summarized in Table 8.3. Detailed results for each cross section are given in Table C.2, Appendix C which lists the cross section numbers, left and right top of levee elevations, left and right freeboard, and the computed water surface elevation.

Table C.2 identifies cross sections where the 100-year flood computed water surface elevation encroaches upon the 3-foot levee freeboard or overtops the levee. Areas where water edge velocities exceed 3 feet per second and 4 feet per second are also shown. Water velocities at the edge of the floodway near the channel are critical due to the erosion potential. Velocities of 3 and 4 feet per second were chosen as screening levels due to the lack of information on the construction of the levees.

Table 8.3
HEC-RAS Model Results for the 100-Year Flood Conditions With Enhancements

(Combined Length of Right and Left Levees in Miles)

Management Unit	Levee or Right-of-Way Over-topped	Freeboard Less Than 1 foot	Freeboard Less Than 3 feet	Edge Velocity Above 4 ft/s	Edge Velocity Between 3 and 4 ft/s
Upper Rincon	0.2	1.2	4.4	0.2	0.9
Lower Rincon	1.8	1.8	6	1	2.4
Seldon Canyon	2.6	0.1	1	0	0.2
Upper Mesilla	1.2	0.9	3.7	0	1.3
Las Cruces	0	0	4.8	0	1.9
Lower Mesilla	1.2	0.5	18.5	0.9	8.3
El Paso	6.9	4.6	21.9	1.1	7.8
Total Miles	**13.9**	**9.1**	**60.3**	**3.2**	**22.8**

Figure 8.2 Schematic of Hydraulic Model Results

8.2.5 Comparison with Current Conditions

Table 8.4 shows the difference between post-enhancement and current levee overtopping potential. Table C.2 shows the differences in the 100-year flood computed water surface elevation between the USACE's HEC-2 results (current conditions) and the HEC-RAS results (with enhancements). Table 8.4 below shows that proposed enhancements to the floodway areas do not significantly change the current situation of overtopping potential or levee erosion potential throughout the Project for Alternatives 2, 3, or 4. The levee reconstruction required is similar for each alternative.

Table 8.4
HEC-RAS Model Results for the 100-Year Flood Conditions
Changes Due to Enhancements

(Combined Length of Right and Left Levees in Miles)

Management Unit	Levee or Right-of-Way Over-topped	Freeboard Less Than 1 foot	Freeboard Less Than 3 feet	Edge Velocity Above 4 ft/s	Edge Velocity Between 3 and 4 ft/s
Upper Rincon	0.2	0.7	0.5	-0.1	-0.4
Lower Rincon	0.1	0.1	1.3	0.0	-0.5
Seldon Canyon	0	-0.1	-0.3	0.0	-0.1
Upper Mesilla	0	0	0.3	-0.1	-0.5
Las Cruces	0	0	1.3	0.0	-1.2
Lower Mesilla	-0.1	-0.1	3.1	0.1	-3.4
El Paso	0.5	1.8	-0.2	-0.3	-3.9
Total Miles	**0.7**	**2.4**	**6**	**-0.4**	**-10.0**

8.3 Flood Control Remedies and Recommendations

The USACE's recommendations in Section 8.1.2 are still appropriate. However, the New Mexico Highway Department is not planning to replace any bridges except the Courchesne Bridge. The Courchesne Bridge proposed cross section has been included in the HEC-RAS model.

Several options were considered with respect to overtopping of levees or rights-of-way, encroachment on freeboard, or excessive velocities.

- Add levee where none exists;
- Raise or fortify existing levee;
- Set back levee or right-of-way; and
- Implement no additional flood protection measures.

Each of these options was included as part of the overall remedy for flood damage reduction. However, a more detailed flood damage reduction study using a risk-based analysis is required to optimize the overall investment of flood control resources.

The general criteria for selecting a flood damage reduction option was based on protection of existing residential, commercial, or industrial structures. Where flooding would be limited by natural topography to agricultural land, even if flooding included land outside USIBWC right-of-way, no additional flood protection was included.

For most areas with levees, the adjacent land elevations outside the USIBWC right-of-way are relatively flat across the valley floor. Therefore, failure of the levee would subject large areas, including structures, to flooding. In these cases, the remedy was to raise or fortify the levee if modeling data indicated encroachment of the freeboard or excessive water velocities. Table 8.5 shows the miles of levee modifications indicated by the HEC-RAS modeling.

Table 8.5 Flood Control Measures for Deficient Levees

(Combined Length of Right and Left Levees in Miles)

Management Unit	Set back Right-of-Way	None	Add levee	Set Back Levee	Raise Levee
Upper Rincon	3.4	26.6	0	0	0
Lower Rincon	0	4	0.6	5.8	1.6
Seldon Canyon	0	14.1	1.3	0	0
Upper Mesilla	0	6.2	0	0	3.1
Las Cruces	0	0	0	0	5.2
Lower Mesilla	0	1	0	3.1	16.9
El Paso	0.7	2.3	7.2	0	28.6
Total Miles	**4.1**	**54.2**	**9.1**	**8.9**	**55.4**

The set back of levees was a component of several enhancement sites in order to encompass additional acreage for riparian or uplands habitat. Water surface elevations at some sites will be reduced because of the wider floodway. The flood control benefits of levee setbacks are based on the attenuation of peak flows within the retention volume of the expanded floodway. These benefits are a function of the timing and duration of the peak flow and the position of the setback relative to flood prone areas or deficient levees. A more detailed flood damage reduction study would be needed to evaluate the dynamic behavior of the peak flood flows and the optimum location of floodway detention volume provided by levee setbacks.

Aerial photographs of the floodplain near deficient levees were reviewed to identify agricultural land adjacent to the existing right-of-way that could be incorporated into flood control strategies. These areas could be enclosed within a realigned levee and subjected to the flooding during the 100-year event. The areas could be purchased by USIBWC or could continue in agricultural production with the owner granting a flood easement. These candidate areas are not included in the alternatives identified for the EIS because they could not be evaluated for flood control purposes within this study. Table 8.6 lists the cross section number (miles above American Dam), area, and modified levee length for these flood control sites.

Table 8.6 Candidate Flood Control Sites

Miles from American Dam	Side (Looking Downstream)	Area (acres)	Modified Levee Length (ft)
96	Left	35	4,300
91	Left	75	6,100
83.4	Right	110	7,500
79.8	Right	125	7,600
77.5	Right	165	7,500
76.3	Left	55	3,300
75.3	Left	195	12,000
52.6	Left	45	4,000
50.6	Right	120	9,500
47.8	Left	55	5,500
45.5	Left	75	7,200
43.4	Left	45	4,600
41.9	Left	235	12,600
Total		**1,335**	**91,700**

8.4 Assumptions and Limitations of the Model

It is imperative to understand the results of the model within its limitations. HEC-RAS is currently capable of performing one-dimensional water surface profile calculations for steady-state conditions with gradual changes in flow due to inflows from tributaries. The model is capable of modeling flow in both natural and constructed channels. The following assumptions are implicit in the analytical expressions used in the current version of the program:

1. Steady-state conditions;
2. Flow is gradually varied where tributaries enter the main channel;
3. Flow is one-dimensional; and
4. River channels have less than 1:10 slopes.

Flow conditions are assumed to be steady state because time-dependent terms are not included in the energy equation. Flow within the main channel is assumed to be gradually varied at tributary inflow locations because the mathematical equations used are based on the premise that a hydrostatic pressure distribution exists at each cross section. At locations where the flow is rapidly varied (at hydraulic structures such as bridges, culverts, and weirs), the program switches to the momentum equation or other empirical equations. Flow is assumed to be one-dimensional (i.e., velocity components in directions other than the direction of flow are not accounted for) because the mathematical equations used are based on the premise that the total energy head is the same for all points in a cross section. Small channel slopes are assumed because the pressure head in the mathematical equations used is represented by the water depth measured vertically. The program for this study does not have the capability of dealing with movable boundaries (i.e., sediment transport), or hydrograph routing, which would allow varying discharge rates to be calculated as the floodplain cross section varies.

The topographic information available is limited to the digital elevation model, which the USACE produced for the 1995 study. This information was compiled for the USIBWC right-of-way and extends outside the right-of-way for only a very limited distance. The topographic information does not include potential floodway areas located beyond this limited distance from the right-of-way. This precludes modeling the flood control effect of potential levee setbacks significantly outside the right-of-way.

SECTION 9
ALTERNATIVE SELECTION

The preferred alternative is the course of action for future river management chosen by the USIBWC following evaluation of the five alternatives using relevant cost and non-cost criteria. The following section describes the selection process and the rationale for selecting Alternative 3, Integrated USIBWC Land Management as the preferred alternative.

9.1 Preferred Alternative Selection Process

The selection process considered the combination of actions for each alternative and their effect on the current USIBWC mission and on the biological systems associated with the Rio Grande in the Project area.

9.1.1 Alternatives and Objectives

The five alternatives were formulated with three river management objectives in mind:

- USIBWC mission of water delivery and flood control;
- Environmental enhancement and restoration; and
- Feasibility of implementation.

The alternatives can be qualitatively considered to fall along a continuum when considering the objectives as shown in Table 9.1, below.

Table 9.1 Alternatives and River Management Objectives

Alternative	USIBWC Mission	Environmental Enhancement and Restoration	Feasibility of Implementation
1. No Action	*Historic*	*Limited*	*Current Practice*
2. Modified Operation and Maintenance	↓	↓	↓
3. USIBWC Integrated Land Management			
4. Targeted River Restoration			
5. Watershed Management	*Increased Expectations*	*Large Area (Watershed)*	*Complex and Expensive*

The process for selecting the preferred alternative attempted to arrive at an optimum course of action to satisfy each objective.

9.1.2 Impact on USIBWC Mission

Flood Control

As described in Section 5, hydraulic modeling indicates that water levels and velocities within the floodway resulting from a 100-year storm event have the potential to cause significant flooding of agricultural, commercial, residential, and industrial areas in the Rio Grande Valley. Alternative 1, the No-Action alternative, does not address flood protection deficiencies. Alternatives 2 through 5 provide for levee modifications to protect structures from the 100-year storm although some agricultural land without structural improvements will still be subject to flooding. The magnitude of flood damage reduction due to the five alternatives was not determined. Alternatives 4 and 5 have the potential to provide greater flood protection and damage reduction by incorporating floodplain areas outside the existing USIBWC right-of-way.

Water Delivery

Each alternative includes actions to maintain the operational status of the current irrigation water conveyance, diversion, and drainage systems. Accumulation of sediments in the river channel will be controlled by dredging to ensure that the channel's hydraulic capacity is sufficient for irrigation flows. Dredging in the main channel from Leasburg Bridge to Shalem Bridge is currently planned by USIBWC and is included in each alternative.

Alternative 2 specifies that dredging within the main channel through Seldon Canyon will not be performed in the future. Alternatives 3 through 5 include widening the cross section of the channel in some locations by adding channel splits or changing the slope of the channel bank. This will help ensure conveyance of irrigation flows through these areas.

Another aspect of water delivery is the volume of water losses due to evaporation, seepage, and evapotranspiration. Alternatives 3 through 5 will result in additional water losses compared with the No-Action alternative. For Alternative 5, additional water consumption will occur due to minimum instream flows and water being released to mimic a natural spring hydrograph. Water losses impact water delivery since the water is not available for irrigation.

9.1.3 Environmental Restoration and Enhancement

As described in Section 7, the five alternatives achieve varying degrees of environmental enhancement by establishing, improving, or preserving aquatic, wetland, riparian, and terrestrial habitat. Restoration of the ecosytem to a condition prior to human modification is not an alternative that could be implemented.

In general, the more land area utilized for enhancement, the greater the expected benefit, provided sufficient water can be supplied to support the type of habitat appropriate for area. Table 9.2 shows a summary of the habitat areas for each alternative as well as the HUs, which account for the value of different types of habitat.

Table 9.2 Habitat Area for Each Alternative

	Aquatic Habitat (Acres)	Riparian Habitat (Acres)	Uplands Habitat (Acres)	Wetland Habitat (Acres)	Total Habitat (Acres)	Total Habitat Units
Alt. 1	802	2,519	2,189	134	5,644	1,864
Alt. 2	802	2,487	2,189	166	5,644	1,916
Alt. 3	810	2,404	2,189	253	5,656	3,078
Alt. 4	810	3,213	2,334	458	6,815	3,886
Alt. 5	810	3,213	2,334	458	6,815	3,886

9.1.4 Feasibility of Implementation

The feasibility of implementation was the third river management objective considered in formulating and evaluating the five alternatives. Overall, cost is the most important criteria for measuring feasibility. Other criteria are water consumption and land requirements. The criteria are described below.

Cost Analysis of Alternatives

Capital Costs

Capital costs of each action were developed using unit cost figures from standard engineering cost references (Means, 2000). Costs were estimated as increases above the current operation (increases over Alternative 1). Table 9.3 shows the resulting unit capital costs. Additional details on assumptions used for developing costs are described below. Detailed cost tables for each site and alternatives are provided in Appendix D.

Levee Construction

Costs for all levee modifications, including new and raised levees, were based on a 5-foot levee height. The following additional assumptions were used.

- Levees to be constructed with 3 to 1 slopes on the river side and 2.5 to 1 slopes on the land side.
- Suitable construction materials located within a 10-mile round trip of the site.
- Compaction of levee materials with two passes of a sheepsfoot roller over 12-inch lifts at optimum moisture content.
- Levee crowns covered with road base material 9 inches deep by 15 feet wide.
- Levee slopes covered with 3 inches of top soil, seeded, and temporarily irrigated.

Table 9.3 Unit Capital Costs

	Capital Cost	Unit	Comment
PROJECT FUNCTIONALITY (USIBWC MISSION)			
Raise levees/add flood control structures	$ 800,000	mile	5 ft levee
Modify dredging at arroyos			
Modify spoil disposal locations/practices			
Acquire flood easements and set back levees	$ 24,000	acre	5 ft levee around 50 acres
Reduce dredging of pilot channel			
Reduce runoff entering river during floods			
Erosion control/dams in tributaries	$ 3,000,000	dam	Rough estimate
AQUATIC / RIPARIAN HABITAT ENHANCEMENTS			
Mouth of Arroyos/Canyons			
Retain/expand existing groin structures			
Retain/expand existing weirs, embayments			
Additional groin locations	$ 2,000	unit	10 feet long
Additional weir/embayment locations	$ 32,400	unit	Groin cost
Create/expand wetlands	$ 49,200	acre	1.5 ft excavation
Widen channel	$ 126,000	acre	10:1 bank slope
Water Diversion Structures & Siphons			
Create white-water fish habitat	$ 1,324,000	acre	20:1 in-channel slope
Provide back-water habitat	$ 144,000	acre	0.00075 riverbed slope
Wasteways/Drains			
Reduced maintenance		acre	Add acres to Tamarisk Control
Enhance wetlands	$ 100,000	acre	Sprig planting 12 inches apart
Riparian Vegetation Sites			
Expand remnant bosques/riparian veg.	$ 8,300	acre	Clear and grub. Plant 400 trees per acr
Control invasive vegetation (salt cedar)	$ 7,900	acre	Clear and grub burn residue
Planting sites within right-of-way	$ 8,300	acre	Native riparian vegetation
Planting sites outside right-of-way	$ 10,300	acre	Native riparian vegetation
Land purchases for habitat	$ 10,000	acre	Farm land w/water rights
USIBWC Land Management			
Retain existing no-mow zones	$ -	acre	Add acres to Tamarisk Control
Additional no-mow zones	$ -	acre	Add acres to Tamarisk Control
Discontinue leases	$ -	acre	Add to no-mow zone
RESTORATION OF FLUVIAL PROCESSES			
Old Channels & Oxbows			
Channel splits right-of-way	$ 339,000	acre	1000 ft length
Embayments within right-of-way	$ 6,500	unit	10 ft by 30 ft
Levee setback	$ 24,000	acre	5 ft levee around 50 acres
Control salt cedar outside right-of-way	$ 7,900	acre	Burn residue
New meanders outside right-of-way	$ 359,000	acre	1000 ft length
Bank overflow by shave downs	$ 126,000	acre	10:1 bank slope
Create/expand wetlands outside right-of-way	$ 59,000	acre	1.5 foot excavation
Flow Regime Modification			
Allow seasonal peak flows			
Establish minimum in-stream flows			
MULTIPURPOSE PROJECT MANAGEMENT			
Add recreational areas	$ 100,000	acre	Rough estimate
Interagency cooperation agreements			
Improve water quality, water conservation	$ 8,600	acre	High efficiency sprinkler irrigation

Disposal of Dredged and Excavated Material

This Alternatives Report assumes that the practice of placing dredged or excavated material within the floodway will not be feasible in the future due to lack of space. Therefore, all actions involving dredging and excavation include costs for disposal sites. The following assumptions were used for these costs:

- Stack at 4 to 1 slope up to 50 feet high;
- 5-mile round trip to site;
- 4-acre site, property costs of $10,000 per acre; and
- Slopes seeded and temporarily irrigated.

Channel Splits

Costs for split channels were calculated from the sum of excavation and disposal costs. Major assumptions are listed below.

- Width of 100 feet, depth of 10 feet, and length of 1,000 feet;
- Bank slope of 10 to 1; and
- Erosion control blanket on 15-foot wide strip of both banks.

Table 9.4 shows the total capital costs for each alternative broken down by flood control costs and other capital costs.

Table 9.4 Capital Costs for Each Alternative
($ Million)

Alternative	Flood Control Costs	Other Capital Costs	Total Capital Costs
1. No Action	-	-	-
2. Modified Operation and Maintenance	55.9	9.2	65.1
3. USIBWC Integrated Land Management	55.9	66.1	122.0
4. Targeted River Restoration	59.2	113.4	172.6
5. Watershed Management	59.2	144.8	204.0

Operation and Maintenance Costs

Water consumption by each alternative was evaluated for both vegetation and hydraulic or instream uses. Vegetation use by evapotranspiration was calculated in terms of the increase compared with mowed grass. Hydraulic uses were calculated from instream flows. Loss of water by evaporation from increased water surface area associated with channel splits, channel widening, and new sediment control dams was included in the total water consumption. Table 9.5 shows the water usage unit rates with key assumptions for each action. Water usage is estimated as the increase over the

Table 9.5 Water Usage Rates

	Rate	Unit	Comment
PROJECT FUNCTIONALITY (USIBWC MISSION)			
Raise levees/add flood control structures			
Modify dredging at arroyos			
Modify spoil disposal locations/practices			
Acquire flood easements and set back levees			Flood area for 5 d every 10 yr
Reduce dredging of pilot channel			
Reduce runoff entering river during floods			
Erosion control/dams in tributaries			Fill 35 acres for 3 days every year
AQUATIC / RIPARIAN HABITAT ENHANCEMENTS			
Mouth of Arroyos/Canyons			
Retain/expand existing groin structures			No change in water surface area
Retain/expand existing weirs, embayments			Weir - no change in water surface
Additional groin locations			No change in water surface area
Additional weir/embayment locations			Weir - no change in water surface
Create/expand wetlands	5	ac-ft/acre/year	Wetland vegetation water consumption
Widen channel	4.5	ac-ft/acre/year	Free water surface area increase
Water Diversion Structures & Siphons			
Create white-water fish habitat	2.5	ac-ft/acre/year	Increase evaporation due to turbulence and velocity
Provide back-water habitat			No change in water surface area
Wasteways/Drains			
Reduced maintenance	1.5	ac-ft/acre/year	Increase evapotranspiration from brush/trees over mowed grass
Enhance wetlands	5	ac-ft/acre/year	Wetland vegetation water consumption
Riparian Vegetation Sites			
Expand remnant bosques/riparian veg.	1.5	ac-ft/acre/year	Increase evapotranspiration from brush/trees over mowed grass
Control invasive vegetation (salt cedar)	-1.5	ac-ft/acre/year	Reduced evapotraonspiration from removal
Planting sites within right-of-way	3.5	ac-ft/acre/year	Increase evapotranspiration from brush/trees over mowed grass
Planting sites outside right-of-way			Planting sites outside ROW in agricultural production
Land purchases for habitat			Planting sites outside ROW in agricultural production
USIBWC Land Management			
Retain existing no-mow zones	0	ac-ft/acre/year	Increase evapotranspiration from brush/trees over mowed grass
Additional no-mow zones	1	ac-ft/acre/year	Increase evapotranspiration from brush/trees over mowed grass
Discontinue leases	1	ac-ft/acre/year	Increase evapotranspiration from brush/trees over grazed area
RESTORATION OF FLUVIAL PROCESSES			
Old Channels & Oxbows			
Channel splits right-of-way	4.5	ac-ft/acre/year	Free water surface area increase
Embayments within right-of-way	0.0315	ac-ft/unit/year	Free water surface area increase
Levee setback,	0.0004	ac-ft/acre/year	Flood area for 5 d every 10 yr
Control invasive vegetation (salt cedar) outside ROV	-1.5	ac-ft/acre/year	Reduced evapotraonspiration from removal
New meanders outside ROW	4.5	ac-ft/acre/year	Free water surface area increase
Bank overflow by shave downs	4.5	ac-ft/acre/year	Free water surface area increase
Create/expand wetlands outside ROW	5	ac-ft/acre/year	Wetland vegetation water consumption
Flow Regime Modification			
Allow seasonal peak flows	11901	ac-ft/event	3 days at 5000 cfs
Establish minimum in-stream flows	30000	ac-ft/year	200 cfs minimum
MULTIPURPOSE PROJECT MANAGEMENT			
Add recreational areas	4.5	ac-ft/acre/year	
Interagency cooperation agreements			
Improve water quality, water conservation	-0.5	ac-ft/acre/year	10 percent reduction in water use through conservation

current operation (increase over Alternative 1). Table 9.6 shows the annual water usage for each alternative. The water use rates are elevated for Alternative 5 due to the volume required for seasonal peak flows associated with restoration of natural fluvial processes.

Table 9.6 Annual Water Usage for Each Alternative

Alternative	Water Usage (acre-feet/yr)
1. No Action	-
2. Modified Operation and Maintenance	419
3. USIBWC Integrated Land Management	1,725
4. Targeted River Restoration	1,189
5. Watershed Management	13,153

Annual operation and maintenance costs of each action were estimated as a percentage of the capital costs. In addition, a leased water cost of $250 per acre-foot per year was assumed based on sales from irrigation districts to the Public Service Board of El Paso at $196 per acre-foot per year. Costs are estimated as increases above the current operation (increase above Alternative 1). Table 9.7 shows the total operation and maintenance cost for each alternative broken down by water costs and other costs. Table 9.8 shows the operation and maintenance unit cost with important assumptions included for each action.

Table 9.7 Operation and Maintenance Costs for Each Alternative
($ Million/yr)

Alternative	Water Costs	Other O&M Costs	Total O&M Costs
1. No Action	-	-	-
2. Modified Operation and Maintenance	0.1	3.0	3.1
3. USIBWC Integrated Land Management	0.3	5.8	6.1
4. Targeted River Restoration	0.2	8.2	8.4
5. Watershed Management	3.3	9.4	12.7

Table 9.8 Operation and Maintenance Unit Costs

	O&M Cost	Unit	Comment
PROJECT FUNCTIONALITY (USIBWC MISSION)			
Raise levees/add flood control structures	$32,000	mile/yr	4 percent of capital cost
Modify dredging at arroyos	$1,200	event/yr	Add gravel,cobble,boulders 1/5 yr
Modify spoil disposal locations/practices	$12.41	yd3	5 mi round trip
Acquire flood easements and set back levees	$960	acre/yr	4 percent of capital cost

Table 9.8 Operation and Maintenance Unit Costs

	O&M Cost	Unit	Comment
Reduce dredging of pilot channel	$(16.22)	yd3	Disposal cost 12.41
Reduce runoff entering river during floods			
Erosion control/dams in tributaries	$120,000	dam/yr	4 percent of capital cost
AQUATIC / RIPARIAN HABITAT ENHANCEMENTS			
Mouth of Arroyos/Canyons			
Retain/expand existing groin structures			
Retain/expand existing weirs, embayments			
Additional groin locations	$80	unit/yr	4 percent of capital cost
Additional weir/embayment locations	$1,296	unit/yr	4 percent of capital cost
Create/expand wetlands	$1,968	acre/yr	4 percent of capital cost
Widen channel	$5,040	acre/yr	4 percent of capital cost
Water Diversion Structures & Siphons			
Create white-water fish habitat	$52,960	acre/yr	4 percent of capital cost
Provide back-water habitat	$5,760	acre/yr	4 percent of capital cost
Wasteways/Drains			
Reduced maintenance	$2,333	acre/yr	1/3 yr. Add to tamarisk control
Enhance wetlands	$4,000	acre/yr	4 percent of capital cost
Riparian Vegetation Sites			
Expand remnant bosques/riparian veg.	$332	acre/yr	4 percent of capital cost
Control invasive vegetation (salt cedar)	$790	acre/yr	10 percent of capital cost
Planting sites within ROW	$332	acre/yr	4 percent of capital cost
Planting sites outside ROW	$412	acre/yr	4 percent of capital cost
Land purchases for habitat	$400	acre/yr	4 percent of capital cost
IBWC Land Management			
Retain existing no-mow zones	$-		Add acres to tamarisk control
Additional no-mow zones	$(2,000)	acre/yr	Add acres to tamarisk control
Discontinue leases	$-	acre/yr	No-mow zone
RESTORATION OF FLUVIAL PROCESSES			
Old Channels & Oxbows			
Channel splits ROW	$13,560	acre/yr	4 percent of capital cost
Embayments within ROW	$260	unit/yr	4 percent of capital cost
Levee setback,	$960	acre/yr	4 percent of capital cost
Control invasive vegetation (salt cedar) outside ROW	$790	acre/yr	10 percent of capital cost
New meanders outside ROW	$14,360	acre/yr	4 percent of capital cost

Table 9.8 Operation and Maintenance Unit Costs

	O&M Cost	Unit	Comment
Bank overflow by shave downs	$5,040	acre/yr	4 percent of capital cost
Create/expand wetlands outside ROW	$2,360	acre/yr	4 percent of capital cost
Flow Regime Modification			
Allow seasonal peak flows	$250	acre foot	2000 cfs
Establish minimum in-stream flows	$250	acre foot	200 cfs
MULTIPURPOSE PROJECT MANAGEMENT			
Add recreational areas	$4,000	acre/yr	4 percent of capital cost
Interagency cooperation agreements			
Improve water quality, water conservation	$344	acre/yr	4 percent of capital cost

Life Cycle Costs

The life cycle costs for each action were determined by calculating the present value of the capital and annual costs using a 30-year project life and a 5 percent annual discount factor. Life cycle costs incorporate the annual operating costs and initial construction costs. Capital costs were assumed to occur in the first year. Table 9.9 gives a summary of the costs for each alternative including capital, operation and maintenance, and life cycle costs.

Water Consumption

Water costs are included in the cost analysis by using an estimated market price for the water because it is assumed that a water right is necessary for water consumed by environmental actions. Since the entire volume of water flowing within the Project has been allocated by state authorities, and since USIBWC does not hold any water rights, water must be purchased.

Water use for non-agricultural purposes such as habitat enhancement may require special approval in the State of New Mexico. Even if a transfer of use is approved, there may not be water available for purchase. These issues will impact the feasibility of the alternatives, especially Alternative 5, which requires a large volume of water for instream flows and seasonal peak flows.

Land Requirements

Only property within or immediately adjacent to the current USIBWC right-of-way is attractive for environmental enhancements or flood control. Alternatives 4 and 5 incorporate privately owned property within the enhancement areas based on habitat value. Since no property owners were contacted regarding land sales as part of this report, it is possible that private owners may be unwilling to sell their tracts of land.

Table 9.9 Summary of Costs for Each Alternative ($ Million)

Alternative	Operation and Maintenance Costs (per yr)	Capital Costs	Life Cycle Costs
1. No Action	-	-	-
2. Modified Operation and Maintenance	3.1	65.1	112.0
3. USIBWC Integrated Land Management	6.1	122.0	213.8
4. Targeted River Restoration	8.4	172.6	300.2
5. Watershed Management	12.7	204.0	396.9

Conservation easements or flood easements are other options that may be utilized to provide land for enhancements. USIBWC has ruled out condemnation as an option for acquiring land.

9.1.5 Logical Decisions Analysis

The decision-support software Logical Decisions® was used to systematically compare alternatives based on uniform criteria. By assigning quantitative estimates to each criterion, the software ranks user-defined alternatives so that multiple goals can be achieved. Cumulative values for all criteria are used as a measure of the degree of preference for each alternative.

Logical Decisions® is a tool that helps decision-makers dissect complicated decisions and explicitly walk through a multi-objective evaluation process. Its use requires evaluators to articulate their preferences or bases for making a decision to yield a ranking of the alternatives. Additionally, with clear and explicit bases for making a decision, sensitivity analyses can be performed to test the relative effect of individual criteria on the ranking of the preferred alternative. The following steps summarize the analysis process used in the Logical Decisions® software:

- Identify alternatives to be evaluated;
- Identify goals and criteria to be used as the basis for evaluation;
- Define measures that quantify those criteria, and assign scores to each measure within an alternative;
- Assign relative weights (W_i) to each goal and criteria and define utility functions or “utilities” (U_x); these functions are used to normalize diverse measures such as area, water use, and cost, into a common scale; and
- Compute net utilities for each alternative.

$U_{net} = \quad U_{Goal\ i} = \quad W_i * U_{Criteria\ j}$ (score);

U_{net} = Net utility for an alternative;

$U_{Goal\ i}$ = Utility for Goal i;

W_i = Weight (or relative importance) of Goal i or Criteria j; and

$U_{Criteria\ j}$ = Utility of Criteria j which is a function of the score for a given alternative relative to Criteria j.

Setting Up the Analysis

Five alternatives were formulated for the modified management of the Canalization Project, as described in detail in Section 7. Assessing the relative benefit of those alternatives is complex because they address three competing goals:

- Accomplish USIBWC mission;
- Promote environmental enhancement and restoration; and
- Feasibility of implementation.

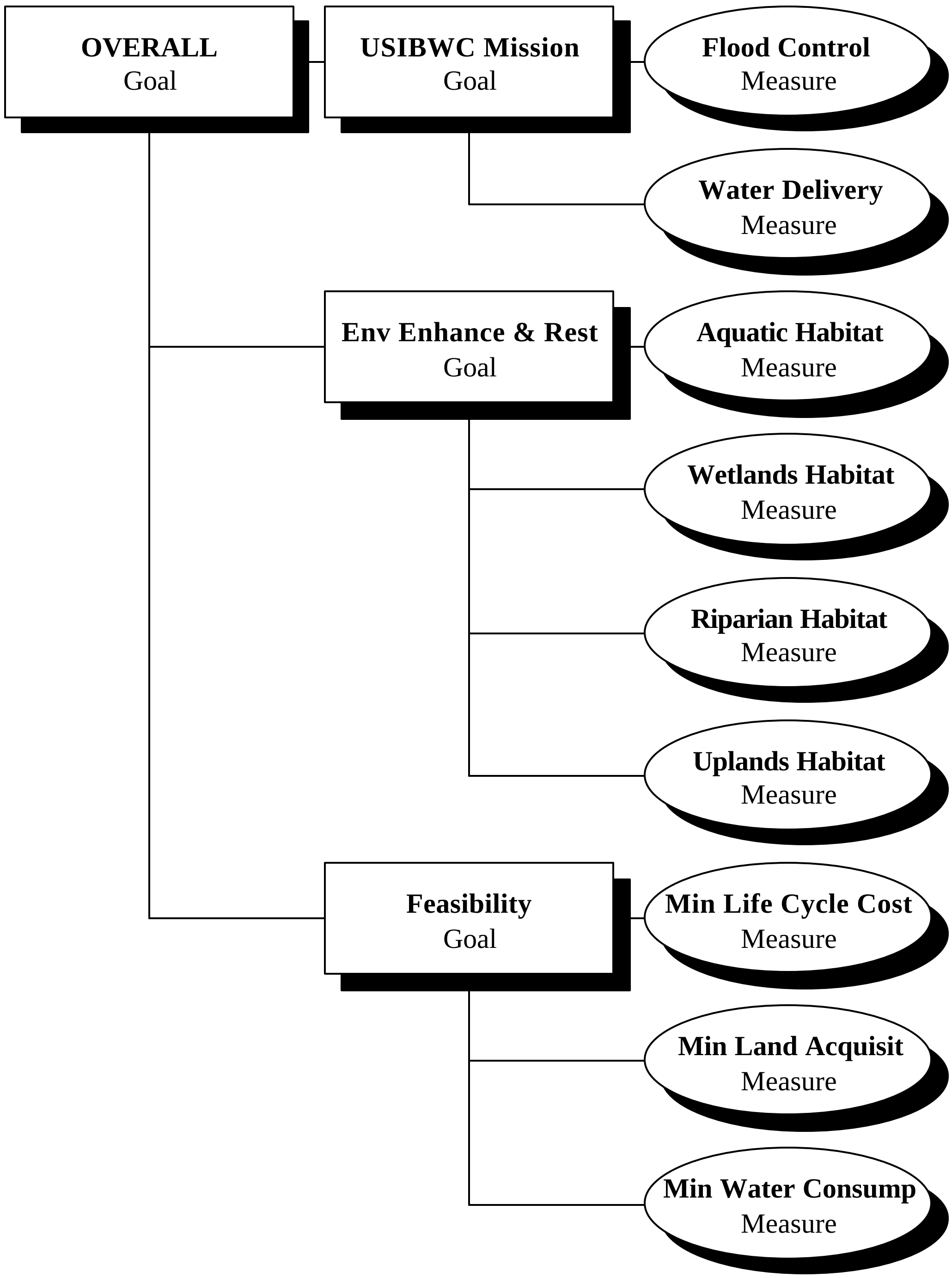
A project alternative may excel in accomplishing one of the goals but not fully accomplish the others. For example, as the ability of an alternative to benefit the environment increases, its feasibility decreases due to resource constraints (funding, land acquisition, or water use requirements). Thus, the objective of the evaluation becomes optimizing the extent to which all goals are met rather than trying to maximize an individual goal.

Figure 9.1 indicates the number of measures or criteria that were assigned to each of the three main goals for comparison between alternatives. Accomplishing USIBWC mission goal was measured based on two criteria, flood control capability and efficiency in required water deliveries. The goal of environmental enhancement and restoration was measured in terms of potential increase in four types of habitats: upland, riparian, aquatic, and wetlands. Achieving the feasibility goal took into account costs for each alternative as well as its requirements for water use and land acquisition.

Table 9.10 presents the scoring for each of the nine measures by individual alternative. The potential environmental enhancement and restoration was quantified on the basis of habitat unit increases. Feasibility was measured using life-cycle costs previously calculated for each alternative (Table 9.9), and requirements for water consumption (Table 9.8) and land acquisition (Appendix D). Measures for project functionality were quantified as follows:

Flood protection was estimated as a fraction of an optimum value of 100 percent. A value of 44 percent was calculated for current conditions based on the length of levees without significant deficiencies (57 out of 130 miles); the current-condition value was assigned to Alternative 1. An improvement in flood protection level to 90

Figure 9.1 Logical Decisions Goals and Criteria



percent was assumed for Alternatives 2 and 3, once significant improvements are made to the existing levees, increasing to 95 percent for Alternative 4 and 100 percent for Alternative 5.

- *Efficiency in water deliveries* was estimated using a subjective scale from 1 to 10. Alternative 1 received the maximum score because the Canalization Project currently meets water delivery requirements for irrigation and transfer to Mexico. Somewhat lower scores, from 8 to 9, were assigned to the other alternatives assuming a partial reduction in water delivery efficiency.

Scores presented in Table 9.10 were entered into the decision-support software to be normalized into utility functions with a single common scale from 0.0 to 1.0. An assumption was made in the analysis that the relationship between the score for all the criteria and their relative utilities is linear. If warranted, nonlinear relationships between scores and utilities could also be incorporated into the analysis. Zero was used as the minimum value for all measures, while a round number moderately above the highest calculated value was used as the maximum, as indicated in Table 9.10.

Table 9.10 Scores for the Project Alternatives

Criteria	Measuring Unit	Maximum Value	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
USIBWC MISSION							
Flood Control	% protection	100	44	90	90	95	100
Water Delivery	subjective score	10	10	9	9	8	9
ENHANCEMENT POTENTIAL							
Aquatic Habitat	habitat units	300	0	26	219	266	266
Wetlands Habitat	habitat units	300	0	36	129	229	229
Riparian Habitat	habitat units	2,500	0	35	1,543	2,081	2,081
Upland Habitat	habitat units	1,000	0	0	519	664	664
FEASIBILITY							
Life-Cycle Cost	millions of dollars	400	0	112	214	300	397
Required Land Acquisition	acres	1,200	0	0	0	1,178	1,178
Required Water Consumption	acre-ft/year	15,000	0	419	1,725	1,189	13,153

Assignment of Relative Weight Factors

Weights, or measures of relative importance, were established for each of the nine criteria as follows:

- Equal weights were assigned to each of the three main goals: USIBWC mission, environmental enhancement potential, and feasibility.
- Within the USIBWC mission goal, an equal weight was assigned to the criteria of flood control and water delivery efficiency.
- Within the feasibility criteria, half of the weight was assigned to life-cycle costs; the other half was split evenly between the two other criteria, need for land acquisition and water consumption requirements.
- Within the goal of environmental enhancements, a relative weight of 3 was used for riparian habitats, a weight of 2 for both wetlands and aquatic habitats, and a weight of 1 for upland habitats. The resulting ratios of 3:2 to 2:1 are equivalent to weight contributions of 38 percent, 25 percent, 25 percent, and 12 percent for those 4 habitats, respectively. The rationale for assigning those values is discussed below.

Weights for environmental enhancements reflect the relative importance assigned by USFWS to habitats along the Rio Grande. In a recent fish and wildlife evaluation of the Project area (Buntjer, 2000), preservation of riparian habitats was assigned the highest priority because they have high value for wildlife and historically have been severely eliminated in the southwest (USFWS Resource Category No. 2). A second priority was given by USFWS to aquatic habitats (USFWS Resource Category No. 3); while diminishing in quality, aquatic habitats are more abundant than riparian habitats. For the analysis of alternatives, wetlands were considered an aquatic habitat. The lowest priority was assigned to upland habitats that represent intervened communities of common occurrence in the southwest and relatively low value for wildlife (USFWS Resource Category No. 4). No high-value habitats that are unique or irreplaceable at the regional or national level (USFWS Resource Category No. 1) were reported by USFWS for the Project area. Table 9.11 summarizes weights assigned to the individual goals and criteria.

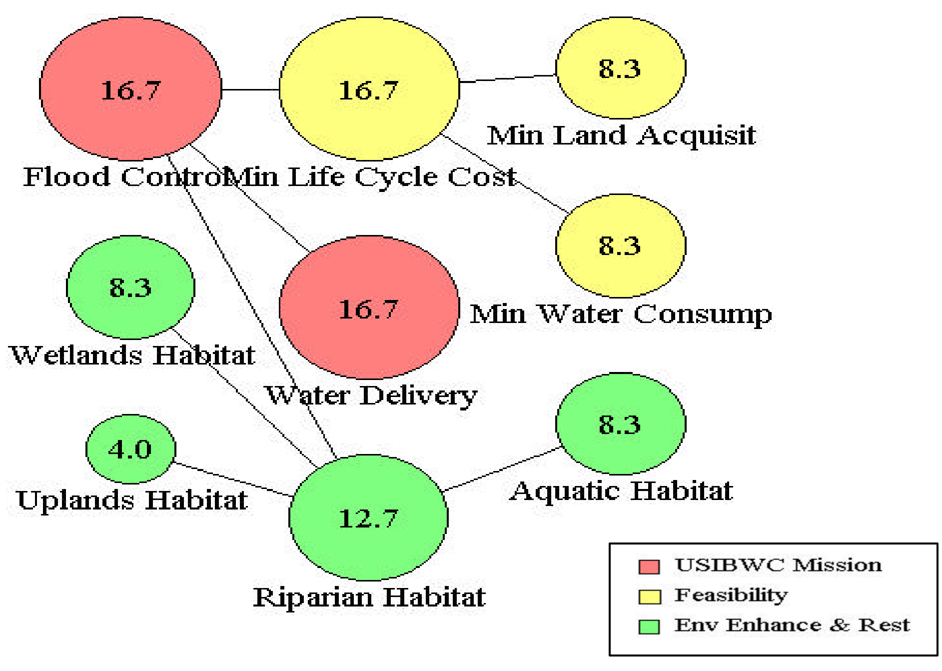
Table 9.11 Weights Assigned to Goals and Criteria

Goal / Criteria	Relative Weight
USIBWC Mission Goal	0.33
Environmental Enhancement & Restoration Goal	0.33
Feasibility Goal	0.33
Total Weight	1.00

Goal / Criteria	Relative Weight
USIBWC Mission Goal	
Flood Control	0.50
Water Delivery Efficiency	0.50
Total Weight	1.00
Environmental Enhancement & Restoration Goal	
Riparian Habitat Increase	0.38
Aquatic Habitat Increase	0.25
Wetlands Habitat Increase	0.25
Uplands Habitat Increase	0.12
Total Weight	1.00
Feasibility Goal	
Minimize Life Cycle Cost	0.50
Minimize Water Consumption	0.25
Minimize Land Acquisition	0.25
Total Weight	1.00

The resulting relative weight for each of the nine criteria is illustrated in Figure 9.2. The size of each circle is proportional to the given criterion's relative weight, while the numbers specify the relative weights normalized to 100 percent. Figure 9.2 shows that, while the three main goals have equal weight in the analysis, the main driving factors for ranking of the alternatives are flood control, efficiency of water deliveries, minimization of life cycle costs, and potential enhancement of riparian habitat. Together, these four criteria make up over 60 percent of the nominal weight for the analysis.

Figure 9.2 Percent Contribution of Individual Criteria in the Analysis



Evaluation

Figure 9.3 presents the ranking of alternatives based on the combination the normalized scores (utility functions) in proportion to their assigned weights. Two graphs are presented, one that ranks the alternatives based on the total value of the utility, and a second one that illustrates how that utility value is distributed among the three main goals (USIBWC mission, potential for environmental enhancements, and feasibility).

Results of the analysis indicate that Alternative 3, integrated management of USIBWC land, has the highest ranking (utility value of 0.73). This alternative, within the defined constraints, optimizes the outcome considering three main goals selected for the evaluation. Alternative 4, targeted river restoration, was ranked second with a utility value of 0.68. This alternative has a greater potential for enhancements than Alternative 3, but its feasibility is significantly lower due to the need for land acquisition and a relatively high life-cycle cost. A comparison of relative benefits of Alternatives 3 and 4 is presented in Figure 9.4. The remaining alternatives have low scores, within the range 0.58 to 0.60, due to low potential for enhancements (Alternatives 1 and 2), or very high cost (Alternative 5).

Figure 9.3 Ranking of Alternatives with Logical Decisions®

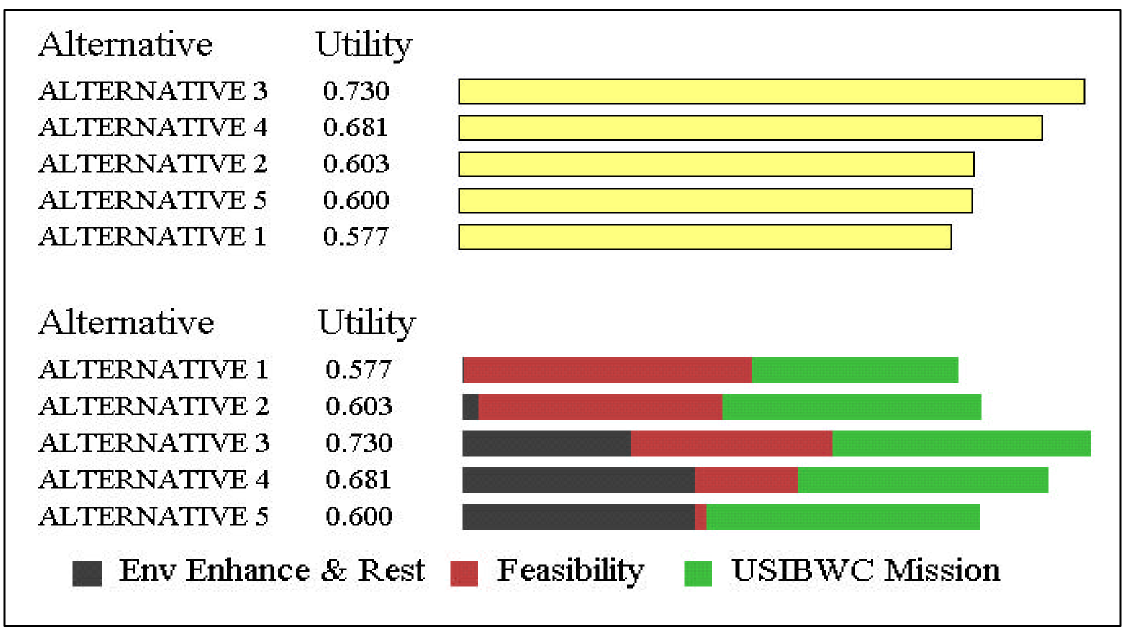
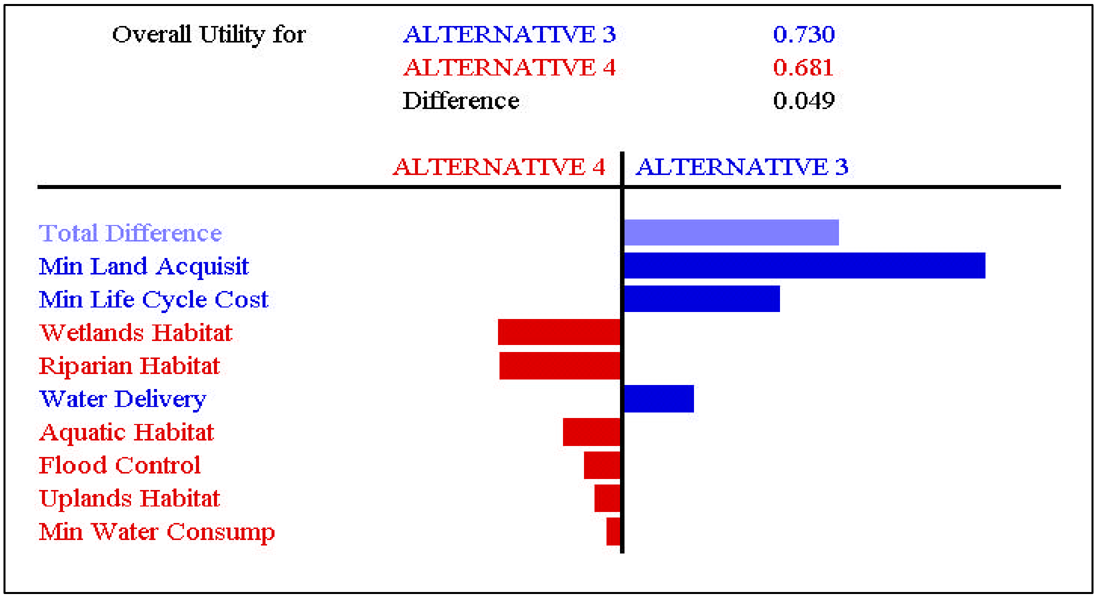


Figure 9.4 Benefit Comparison Between Alternatives 3 and 4



A sensitivity analysis was conducted to assess how the ranking of alternatives would be modified by changes in relative weight among the three main goals. Table 9.12 presents the utility values for four scenarios, to all goals (previous calculations), and three other scenarios that emphasize individual goals:

- *Scenario 1*: 33 percent weight for each goal;
- *Scenario 2*: weight of 50 percent for the USIBWC mission goal, and 25 percent for each of the other two goals;
- *Scenario 3*: weight of 50 percent for the environmental enhancement goal, and 25 percent for each of the other two goals; and
- *Scenario 4*: weight of 50 percent for the feasibility goal, and 25 percent for each of the other 2 goals.

Table 9.12 Sensitivity Analysis for Weighting of Evaluation Goals

	Scenario 1: 33% for Each Goal	Scenario 2: 50% USIBWC Mission	Scenario 3: 50% Potential for Enhancements	Scenario 4: 50% Weight for Feasibility
Alternative 3	0.73	0.78	0.69	0.72
Alternative 4	0.68	0.73	0.71	0.60
Alternative 2	0.60	0.68	0.47	0.67
Alternative 5	0.60	0.69	0.65	0.46
Alternative 1	0.58	0.61	0.44	0.68

The utility scores listed in Table 9.12 show that Alternative 3 is the preferred option even when individual goals are emphasized in the analysis. In three of four scenarios Alternative 3 had the highest ranking, and was second in the fourth scenario (with a slightly lower score than Alternative 4 for scenario 3). These results support the conclusion that Alternative 3 effectively addresses the three main goals of the Project, achieving a balance between cost-effective implementation of environmental enhancements and the need to provide flood protection and maintain adequate water deliveries.

9.2 Preferred River Management Alternative

Alternative 3, Integrated USIBWC Land Management, has been selected as the preferred river management alternative by USIBWC. This alternative will be carried forward to the EIS for more detailed analysis. The following sections provide discussion on the rationale for selecting this action.

9.2.1 Description and Summary of Rationale

Integrated USIBWC Land Management refers to the river management alternative of upgraded flood control measures and additional environmental enhancements within the existing USIBWC Canalization Project right-of-way. A total of 48 potential environmental enhancement sites covering 5,500 acres are included in the alternative. Flood control measures will entail the reconstruction of 73 miles of levees to provide protection against flooding from a 100-year design storm event.

The rationale for this alternative is based on the current USIBWC mission of flood control and water delivery. Flood protection levees are deficient for significant sections of the Project according to hydraulic modeling of floodwater surface elevations and flow velocities. In addition, existing levees were not constructed according to modern engineering design standards and have uncertain structural integrity. Therefore, reconstruction of much of the levee system is probably needed.

The current USIBWC right-of-way provides significant opportunity for habitat enhancement. Although narrow in width, the areas immediately adjacent to the river over which USIBWC has jurisdiction provide the best opportunity for environmental enhancement. By limiting actions to the current right-of-way, USIBWC will be able to implement Alternative 3 without encroaching on private landowners.

Coupled with flood control projects, the environmental enhancements envisioned with Alternative 3 would require significant resources that greatly exceed amounts that have been historically available to the agency. It is likely that the pace and extent of actions will be constrained by the availability of funding in the future. Therefore, Alternative 3, which does not require additional land acquisition, is favored.

At this time, there is no evidence that land acquisition outside the right-of-way will provide a feasible flood control alternative. Although candidate tracts have been identified to set back levees onto private property and encompass additional floodplain, the reduction on floodwater surface levels has not been evaluated. In addition, the availability of property that could serve a flood attenuation function and the magnitude of flood damage savings for given control strategies are not known. For these reasons, the river management alternative that is restricted to the USIBWC right-of-way is a reasonable approach.

9.2.2 Additional Actions

As stated above, the property closest to the river is generally most valuable in terms of habitat enhancement. With the exception of Seldon Canyon, USIBWC already has control over the area immediately adjacent to the river bank. In the future, there may be additional property available for sale in Seldon Canyon adjacent to the river bank or adjacent to the current right-of-way. This situation may present an opportunity for the USIBWC to expand holdings that could be managed for additional wildlife habitat. Some tracts exist adjacent to the right-of-way that are not currently cultivated which USIBWC may be able to procure or share control of through flood easements or conservation easements. Although not within the scope of Alternative 3, these opportunities could be pursued.

Preliminary engineering of flood control measures should begin with a flood damage reduction study using a risk-based analysis to determine costs and benefits of various flooding and flood control scenarios. This will lead to an optimum flood control strategy that may entail other actions besides levee reconstruction as specified in Alternative 3. Results of that study will support funding requests for the optimum control strategy.

9.2.3 Adaptive Management Plan

Due to the large scale and high cost of the preferred alternative, it is envisioned that implementation will occur over several decades. The first step will be a river management plan, which will include details on operation and maintenance of the Project. The plan will also establish a procedure for incorporating environmental enhancements into the overall operation of the Project.

Based on the preferred river management alternative, the USIBWC could expand its mission statement for the Canalization Project to include environmental enhancement as an equal objective along with flood protection and water delivery. The USIBWC would likely require additional staff to implement the enhancement actions, including pursuing funding for projects.

It is envisioned that implementation would be governed using an adaptive management plan approach. The adaptive management plan would identify a governing committee of USIBWC and other state and federal agency personnel to plan and execute environmental enhancements within the Project. The committee, called the "Adaptive Management Committee, would have responsibility for prioritizing enhancement sites and actions. The committee would also have responsibility for obtaining stakeholder input and obtaining funding from outside USIBWC and the U.S. State Department. The USIBWC would retain decision-making authority based on input from the adaptive management committee.

Successfully implementing environmental enhancements at specific sites while maintaining flood control and water delivery capacity will, to a large degree, be an experimental process. The adaptive management plan will include a detailed monitoring program for important indicators to determine the effects of projects. Extensive monitoring of biological systems as well as structural features of the Project is warranted to avoid unintended effects. Routine monitoring and reporting will be established to provide the adaptive management committee and other interested parties the results of actions over time. This data will be used to guide the selection of future enhancement sites and projects.

Tables 9.13 through 9.15 present the lists of sites identified for Alternative 3. The sites have been ranked by total cost (Table 9.13), cost per habitat unit (Table 9.14) and annual water use (Table 9.15). This ranking is a tool that could be used by the adaptive management committee to help prioritize implementation of enhancement projects. As an example, there could be limits on implementation in 1 year of $1,000,000 and 100 acre-feet annual water use. In addition, the adaptive management committee may judge costs exceeding $100,000 per habitat unit as not economically feasible. The tables have highlighted each project that meets those criteria. The projects that meet all criteria would then be selected for implementation that year.

Table 9.13 Alternative 3 Sites Ranked by Total Cost

Site	Life Cycle Cost ($Million)	
Broad Canyon	**$ (0.02)**	
Leasburg Dam	**$ 0.01**	**Bold sites satisfy criteria**
Tipton Arroyo	**$ 0.44**	**of < $1,000,000 cost,**
Seldon Drain	**$ 0.66**	**< 100 ac-ft / yr water use,**
Pole Planting Area	**$ 0.78**	**and <$100,000 / HU.**
Wasteway 18	**$ 0.85**	
Trujillo Arroyo	**$ 0.90**	
Wasteway No. 2A	**$ 0.94**	
Wetlands Unit A	$ 0.99	
Wetlands Unit B	$ 0.99	
Holguin Arroyo	$ 1.06	
Placitas Arroyo	$ 1.20	
Wasteway No. 39	$ 1.29	
Anapra Bridge	$ 1.31	
Wasteway No. 39A	$ 1.48	
Rincon / Reed Arroyos	$ 1.53	
Garfield Drain	$ 1.58	
Levee Setback	$ 1.81	
Wasteway 19	$ 1.83	
Angostura Arroyo	$ 1.98	
Del Rio Drain	$ 2.03	
Sibley Arroyo	$ 2.15	
Old Channel	$ 2.46	
Wasteway No. 5	$ 2.53	
Bignell Arroyo.	$ 2.88	
Private Bosque	$ 3.13	
Green / Tierra Blanca Arroyos	$ 3.18	
Nemexas Drain	$ 3.20	
Mesilla Dam	$ 3.62	
Oxbow Restoration	$ 3.67	
Cottonwod Grove	$ 3.72	
Clark Lateral	$ 3.91	
Montoya Arroyo	$ 4.22	
Wasteway No. 8	$ 4.32	
Hatch Siphon	$ 4.73	
Remnant Bosque / Rincon Siphon	$ 4.74	
Sundland Park West Bank	$ 6.36	
Wasteway 31 and Wasteway 20.	$ 7.41	
Dead Mans Curve	$ 7.47	
Jimenez & Three Saints West Drains.	$ 7.50	
Yeso Arroyo	$ 8.19	
East Drain / Border Steel.	$ 9.56	
NMGF Bosque	$ 10.41	
Wasteway 34	$ 10.80	
Wasteway 35	$ 12.75	
Jaralosa Arroyo / Remnant Bosque	$ 15.33	
Channel Cut	$ 15.60	
Crow Canyon / Channel Cut	$ 26.28	

Table 9.14 Alternative 3 Sites Ranked by Cost per Habitat Unit

Site	Water Use (Acre-feet/yr)
Rincon / Reed Arroyos	-50.0
Angostura Arroyo	-45.0
Cottonwod Grove	-40.5
Nemexas Drain	-25.0
Jimenez & Three Saints West Drains.	-15.0
Anapra Bridge	-15.0
Placitas Arroyo	-10.0
Leasburg Dam	**-7.5**
Del Rio Drain	-5.0
Wasteway No. 39A.	-4.0
Bignell Arroyo.	0.0
Dead Mans Curve	0.0
Broad Canyon	**0.0**
Mesilla Dam	0.0
Trujillo Arroyo	**1.5**
Wasteway 34	3.5
Hatch Siphon	4.5
Tipton Arroyo	**5.0**
Wasteway 35	7.0
Wasteway No. 2A.	**7.5**
Old Channel	11.0
Garfield Drain	12.5
Pole Planting Area	**13.0**
Seldon Drain	**15.0**
Wasteway No. 5	15.5
Wasteway No. 39	16.0
Oxbow Restoration	18.5
Wasteway 18	**20.0**
Wasteway 19	20.0
Sundland Park West Bank	20.0
Clark Lateral	27.5
Wasteway 31 and Wasteway 20.	30.0
Remnant Bosque / Rincon Siphon	32.5
Wasteway No. 8	34.0
East Drain / Border Steel.	42.0
Levee Setback	45.0
NMGF Bosque	45.0
Wetlands Unit A	50.0
Wetlands Unit B	50.0
Yeso Arroyo	52.6
Sibley Arroyo	55.5
Montoya Arroyo	73.0
Holguin Arroyo	99.1
Green / Tierra Blanca Arroyos	112.0
Private Bosque	150.0
Channel Cut	173.0
Jaralosa Arroyo / Remnant Bosque	333.0
Crow Canyon / Channel Cut	347.5

Bold sites satisfy criteria of < $1,000,000 cost, < 100 ac-ft / yr water use, and <$100,000 / HU.

Table 9.15 Alternative 3 Sites Ranked by Annual Water Use

Site	Life Cycle Cost ($Million)*	Habitat Units	Cost Per Habitat Unit ($/HU)	
Broad Canyon	**$ (0.02)**	**1.2**	**$ (20,778)**	
Leasburg Dam	**$ 0.01**	**2.9**	**$ 3,125**	
Angostura Arroyo	$ 1.26	61.6	$ 20,483	
Rincon / Reed Arroyos	$ 1.21	41.0	$ 29,463	
Tipton Arroyo	**$ 0.44**	**14.8**	**$ 30,065**	**Bold sites:**
Trujillo Arroyo	**$ 0.90**	**29.5**	**$ 30,554**	**< $1,000,000**
Anapra Bridge	$ 0.59	16.8	$ 34,853	**< 100 ac-ft/yr and**
Private Bosque	$ 2.81	75.0	$ 37,442	**<$100,000 / HU.**
Placitas Arroyo	$ 1.20	31.0	$ 38,807	
Pole Planting Area	**$ 0.46**	**10.5**	**$ 43,776**	
Jaralosa Arroyo / Remnant Bosque	$ 15.33	335.2	$ 45,725	
Bignell Arroyo.	$ 2.32	50.5	$ 45,923	
Holguin Arroyo	$ 1.06	21.4	$ 49,315	
Sibley Arroyo	$ 2.15	41.5	$ 51,832	
Crow Canyon / Channel Cut	$ 26.28	496.2	$ 52,957	
Cottonwod Grove	$ 1.72	25.7	$ 66,655	
Green / Tierra Blanca Arroyos	$ 3.18	44.5	$ 71,338	
Wasteway 18	**$ 0.85**	**10.8**	**$ 78,391**	
Old Channel	$ 1.34	17.1	$ 78,447	
Levee Setback	$ 1.09	13.4	$ 80,740	
Remnant Bosque / Rincon Siphon	$ 3.86	47.7	$ 81,069	
Del Rio Drain	$ 0.99	10.8	$ 91,478	
Seldon Drain	**$ 0.66**	**7.2**	**$ 91,525**	
Wasteway No. 2A.	**$ 0.70**	**7.2**	**$ 98,069**	
Garfield Drain	$ 1.58	15.8	$ 99,753	
Wasteway No. 39	$ 0.97	9.6	$ 101,605	
Wetlands Unit A	$ 0.99	9.5	$ 104,411	
Montoya Arroyo	$ 4.22	38.5	$ 109,710	
Yeso Arroyo	$ 8.19	73.9	$ 110,876	
Nemexas Drain	$ 1.63	14.1	$ 115,433	
Wasteway 19	$ 1.27	10.5	$ 121,138	
Wasteway No. 39A.	$ 0.76	5.8	$ 132,423	
Wetlands Unit B	$ 0.99	6.9	$ 142,998	
Channel Cut	$ 15.60	107.4	$ 145,276	
NMGF Bosque	$ 6.17	42.0	$ 146,923	
Clark Lateral	$ 2.23	14.9	$ 150,431	
Jimenez & Three Saints West Drains.	$ 3.58	22.1	$ 161,663	
Sundland Park West Bank	$ 4.20	25.7	$ 163,150	
Wasteway No. 5	$ 1.41	7.2	$ 196,760	
Oxbow Restoration	$ 3.67	10.0	$ 366,388	
Wasteway No. 8	$ 2.64	6.8	$ 390,875	
Hatch Siphon	$ 4.73	10.1	$ 470,304	
Wasteway 31 and Wasteway 20.	$ 3.41	4.8	$ 715,552	
Wasteway 35	$ 5.31	6.8	$ 780,745	
East Drain / Border Steel.	$ 4.12	5.0	$ 831,389	
Mesilla Dam	$ 2.82	2.8	$ 1,006,204	
Wasteway 34	$ 4.16	0.5	$ 9,249,112	
Dead Mans Curve	$ 2.83	0.3	$ 9,427,309	

* Flood control capital costs not included

SECTION 10
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APPENDIX A
AERIAL PHOTOGRAPHS OF ENHANCEMENT SITES

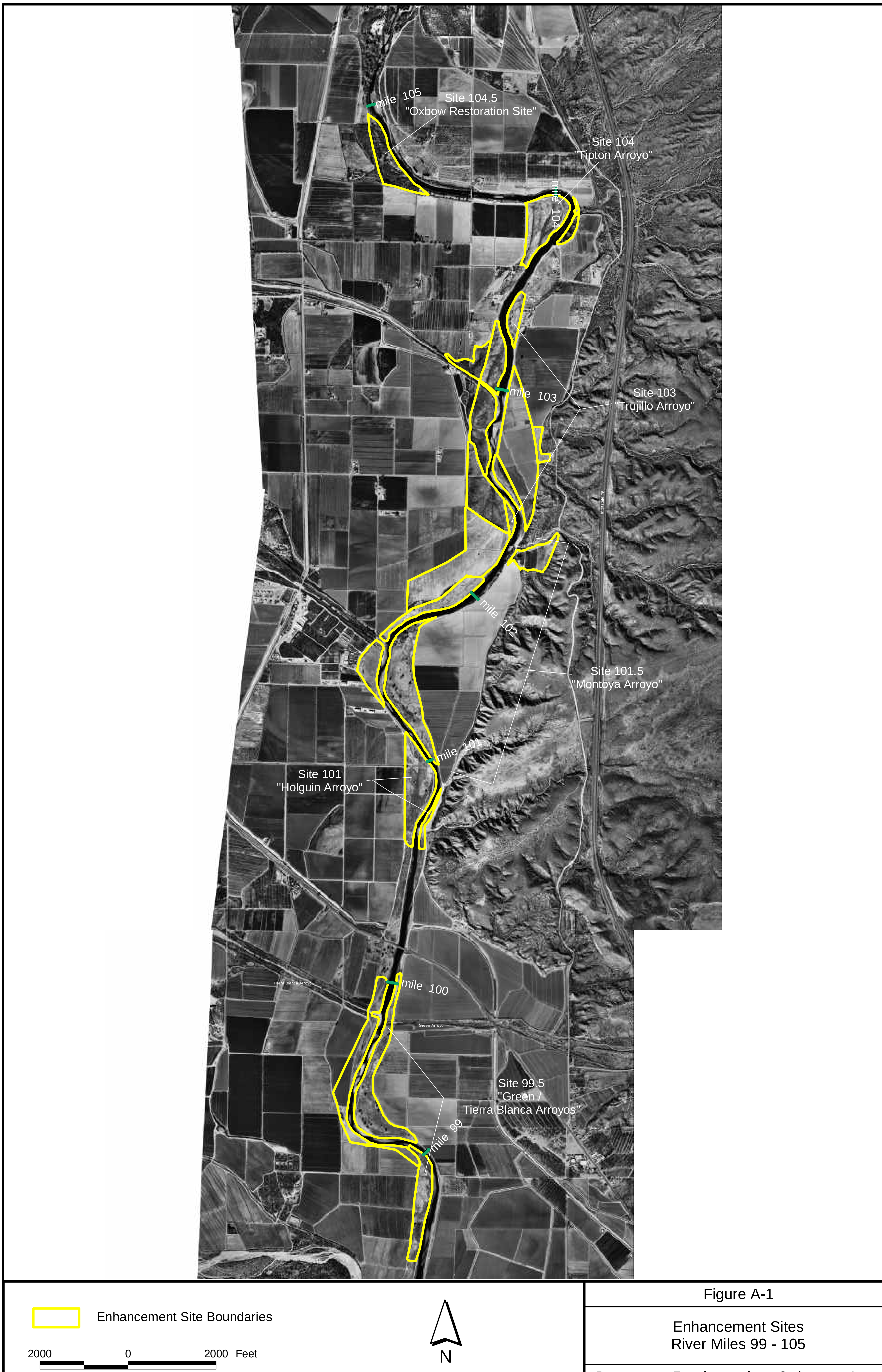
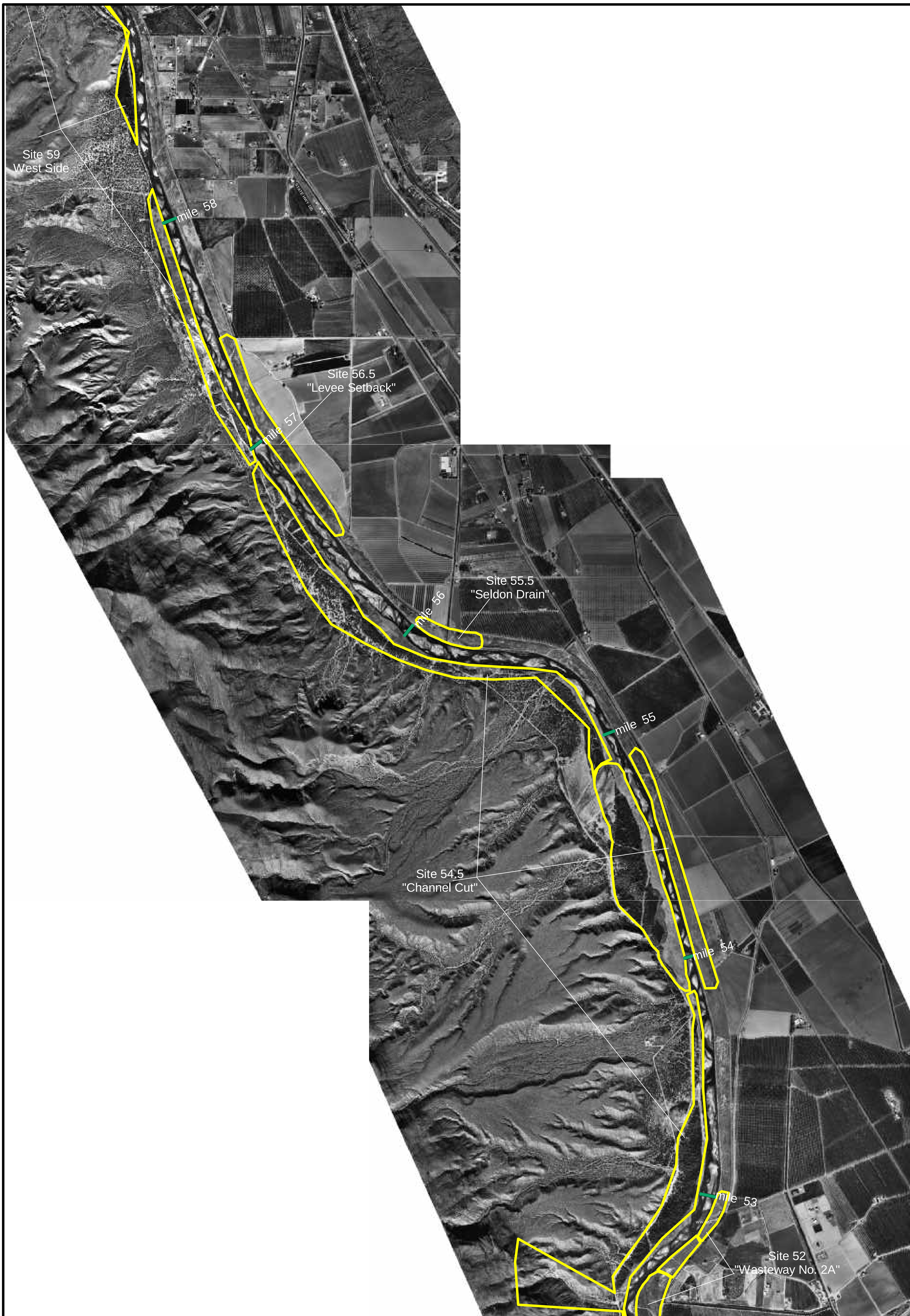


Figure A-1

Enhancement Sites
River Miles 99 - 105

Parsons Engineering Science, Inc.



Enhancement Site Boundaries

2000 0 2000 Feet

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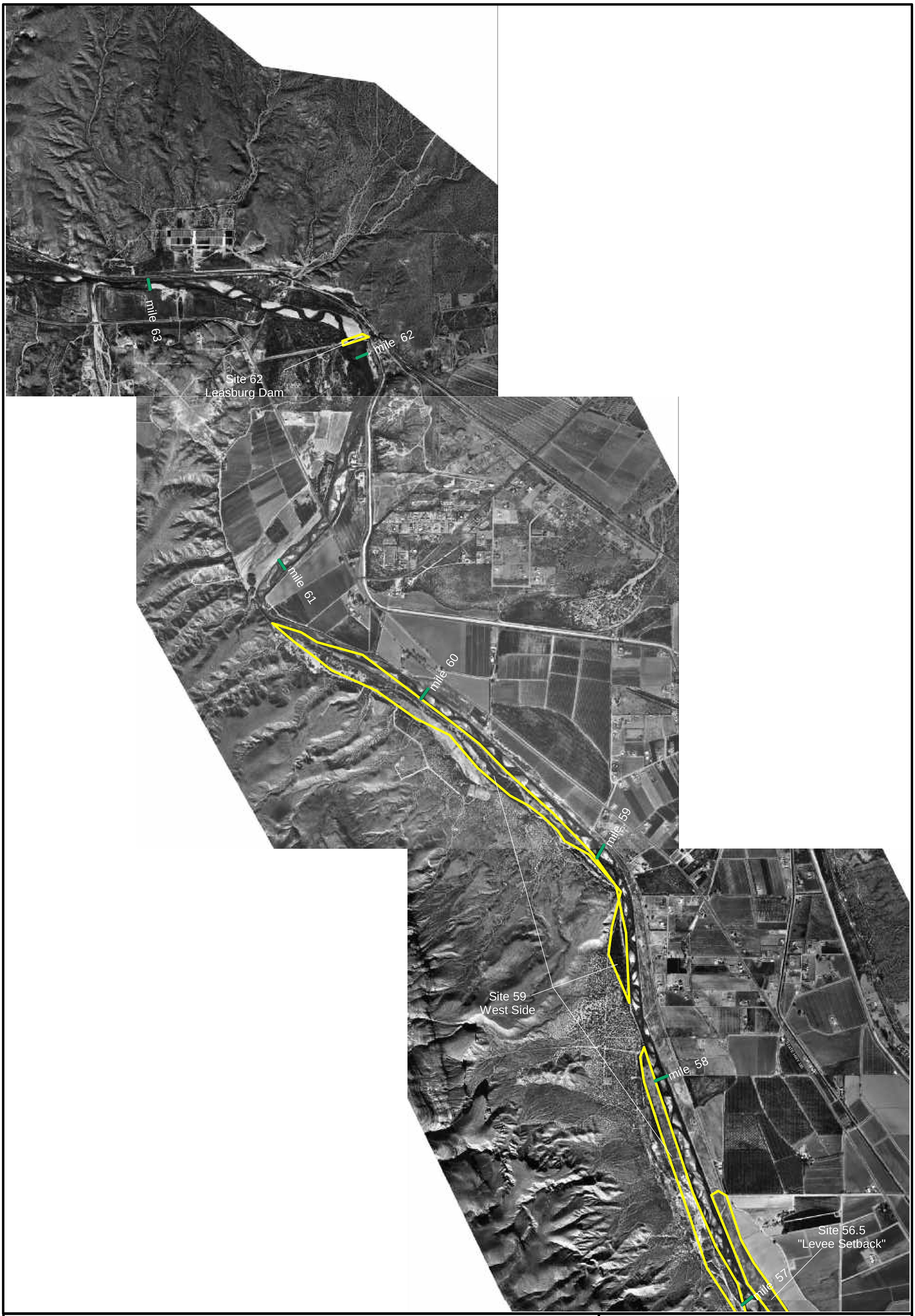
Figure A-8

Enhancement Sites
River Miles 53 - 58

Parsons Engineering Science, Inc.



Enhancement Site Boundaries

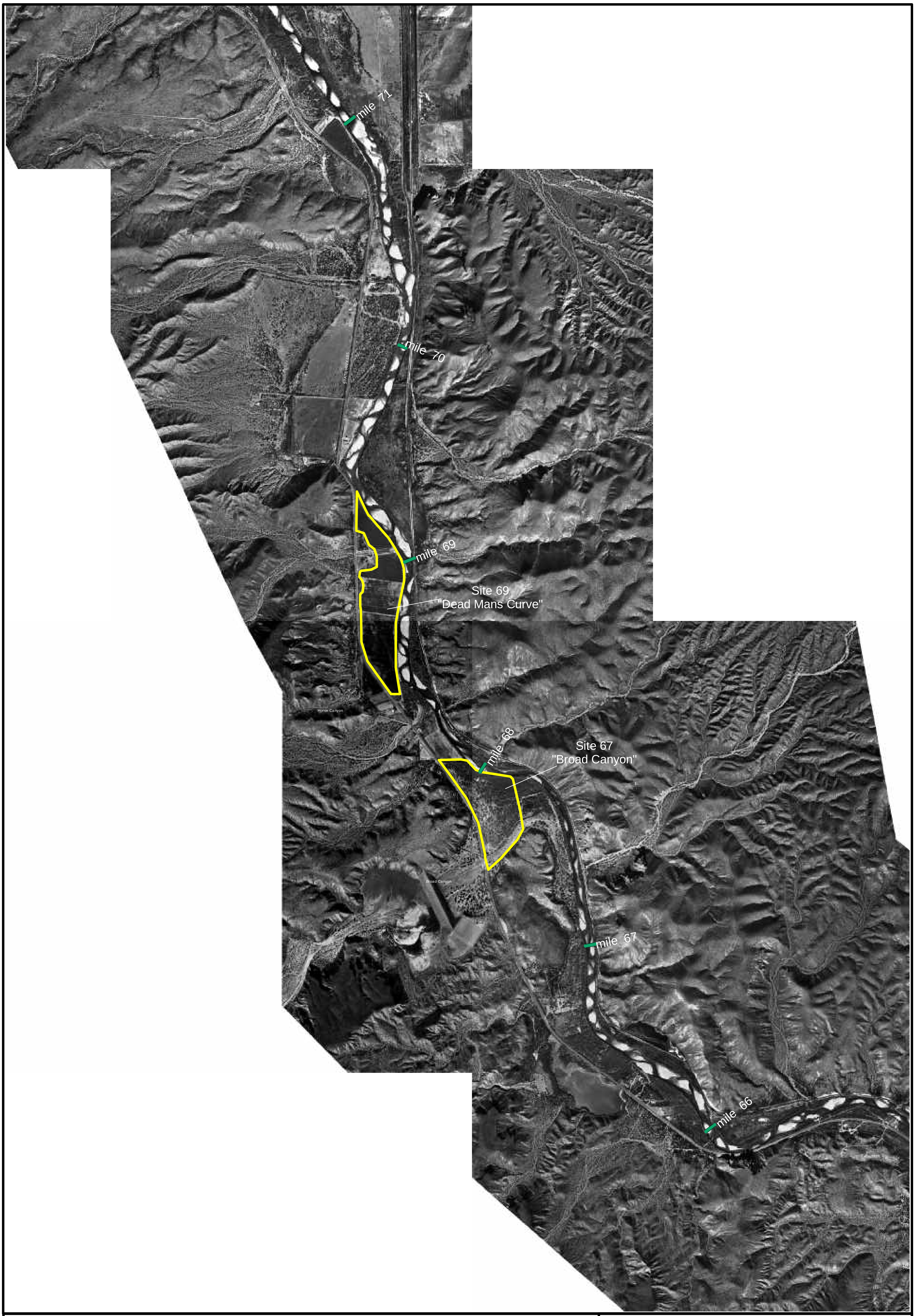
2000 0 2000 Feet

N

Figure A-7

Enhancement Sites
River Miles 57 - 63

Parsons Engineering Science, Inc.



Enhancement Site Boundaries

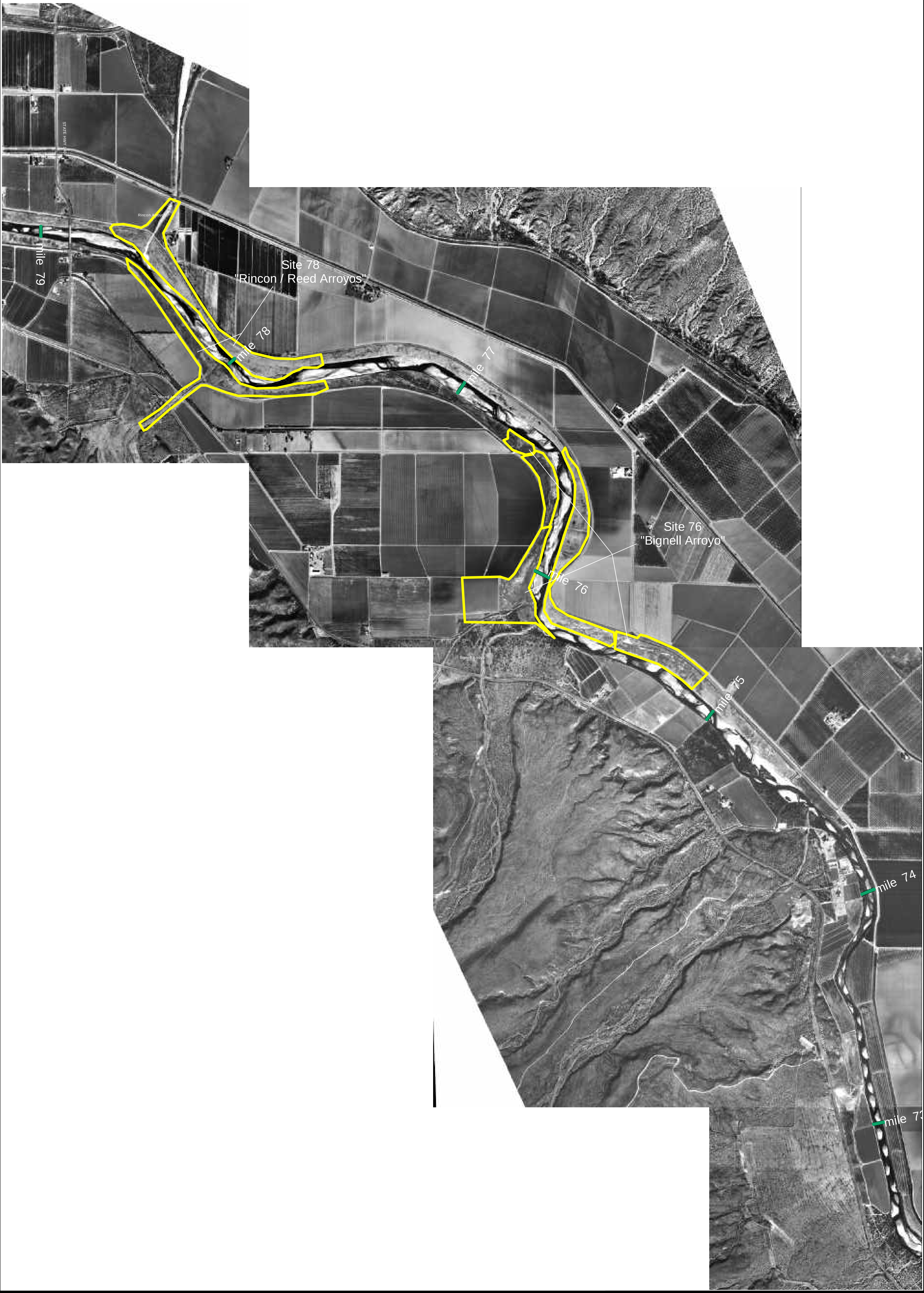
2000 0 2000 Feet

N

Figure A-6

Enhancement Sites
River Miles 66 - 71

Parsons Engineering Science, Inc.



Enhancement Site Boundaries

2000 0 2000 Feet

N

Figure A-5

Enhancement Sites
River Miles 73 - 79

Parsons Engineering Science, Inc.

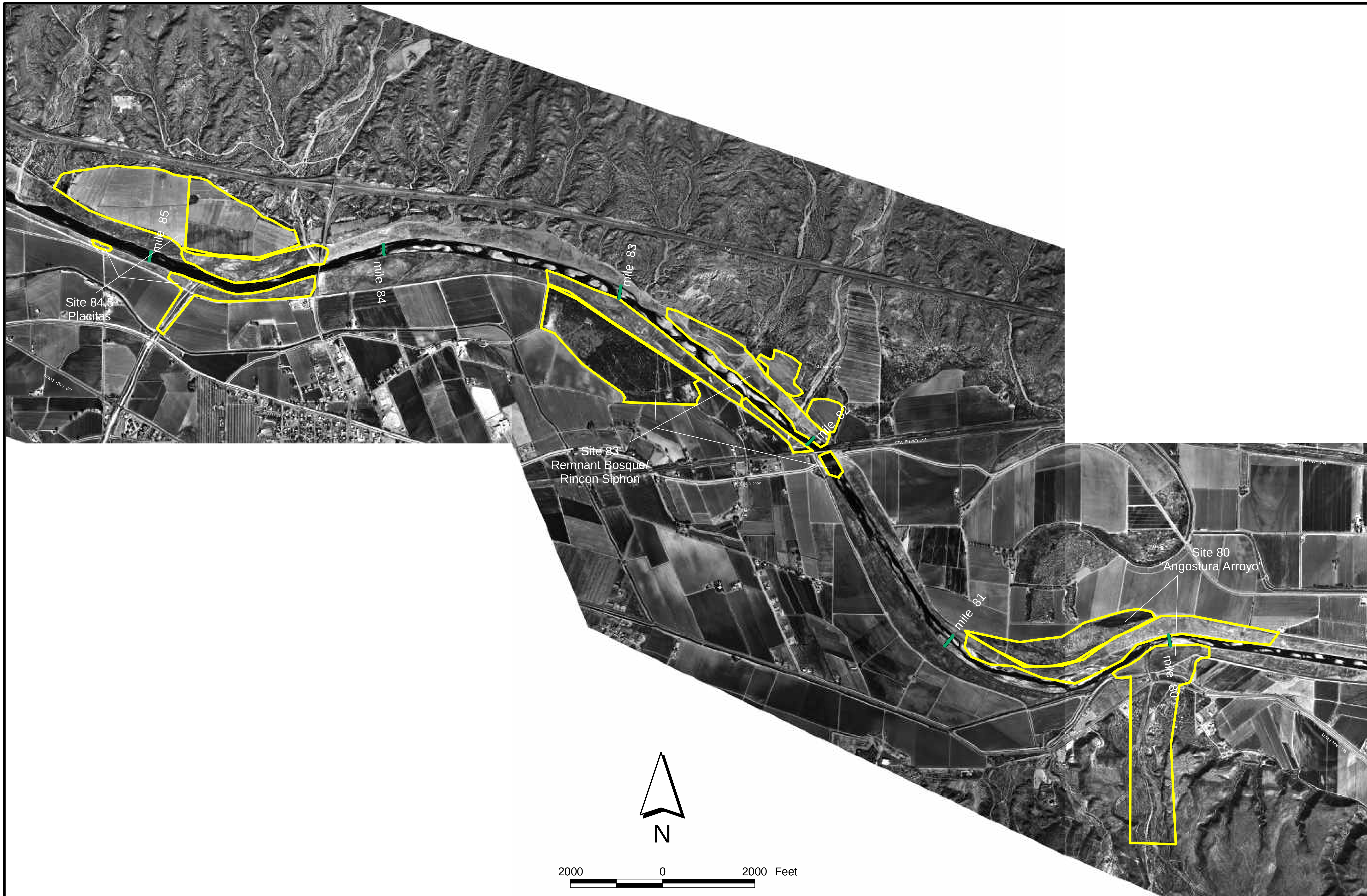


Figure A-4

Enhancement Sites
River Miles 80 - 85

Parsons Engineering Science, Inc.

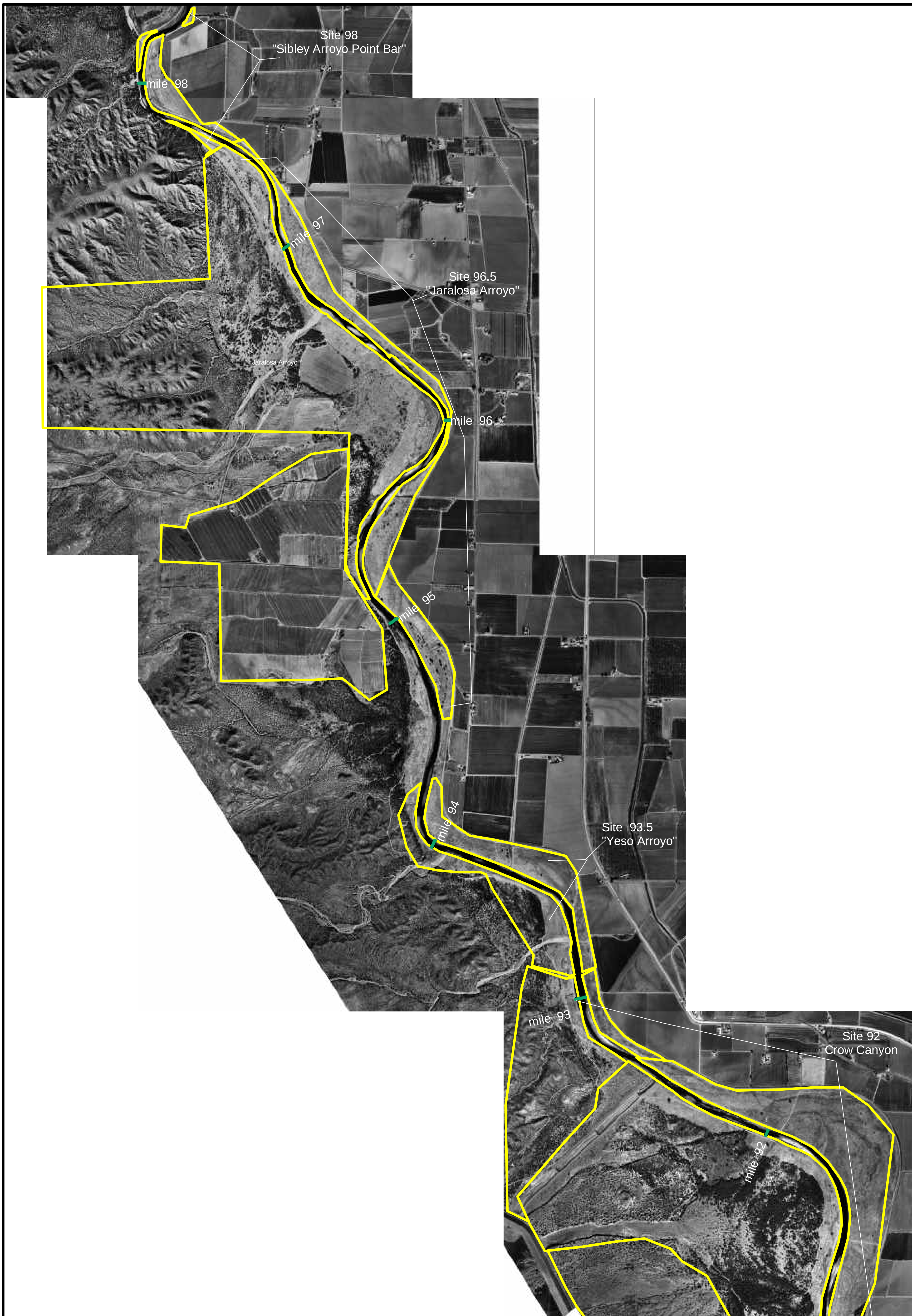
Enhancement Site Boundaries

Figure A-3

Enhancement Sites
River Miles 86 - 93

Parsons Engineering Science, Inc.

Enhancement Site Boundaries



Enhancement Site Boundaries

2000 0 2000 Feet

N

Figure A-2

Enhancement Sites
River Miles 92 - 98

Parsons Engineering Science, Inc.

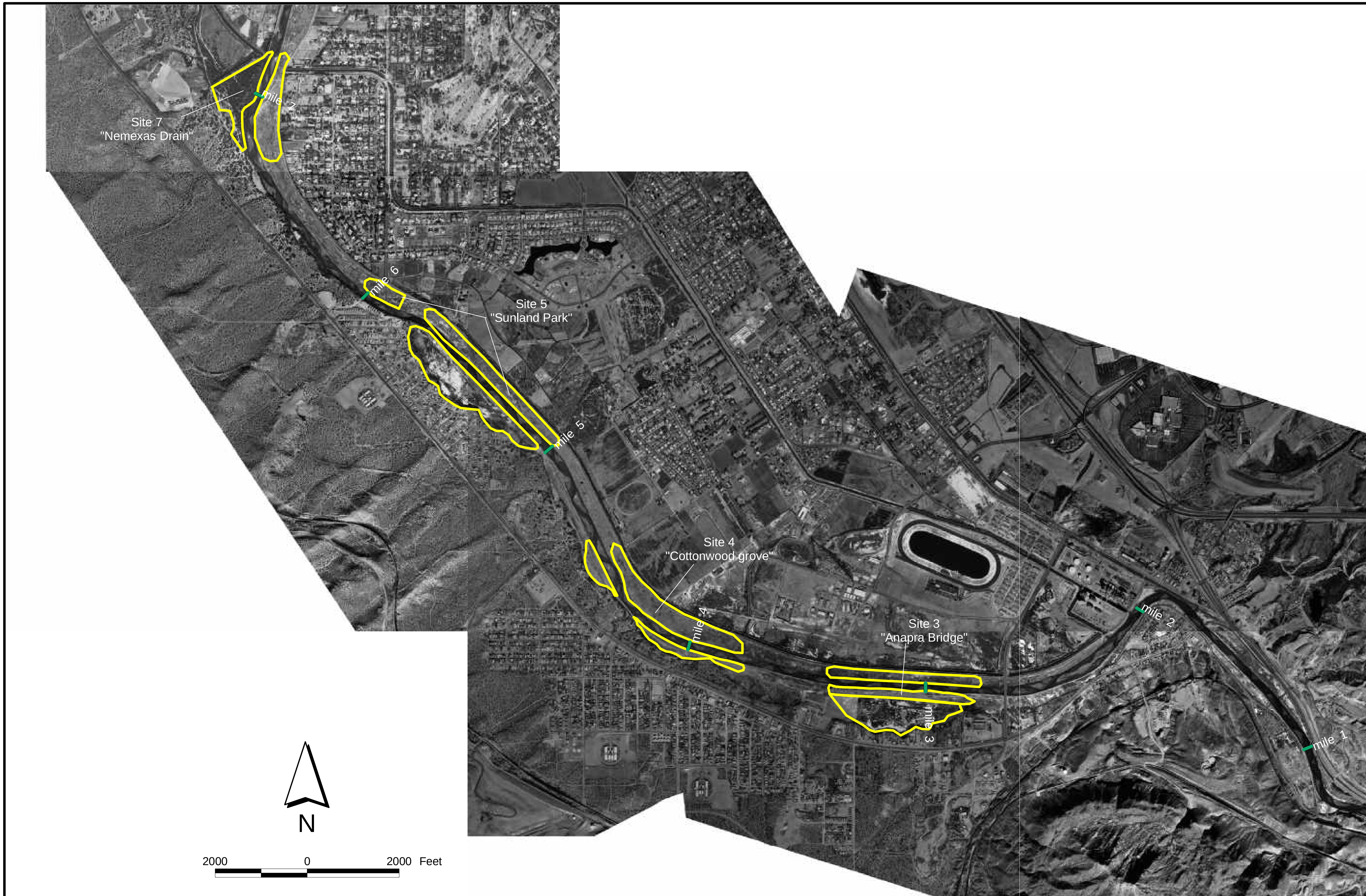


Figure A-15

Enhancement Sites
River Miles 1 - 7

Parsons Engineering Science, Inc.

Enhancement Site Boundaries

Enhancement Site Boundaries

2000 0 2000 Feet

N

Figure A-14

Enhancement Sites
River Miles 5 - 11

Parsons Engineering Science, Inc.

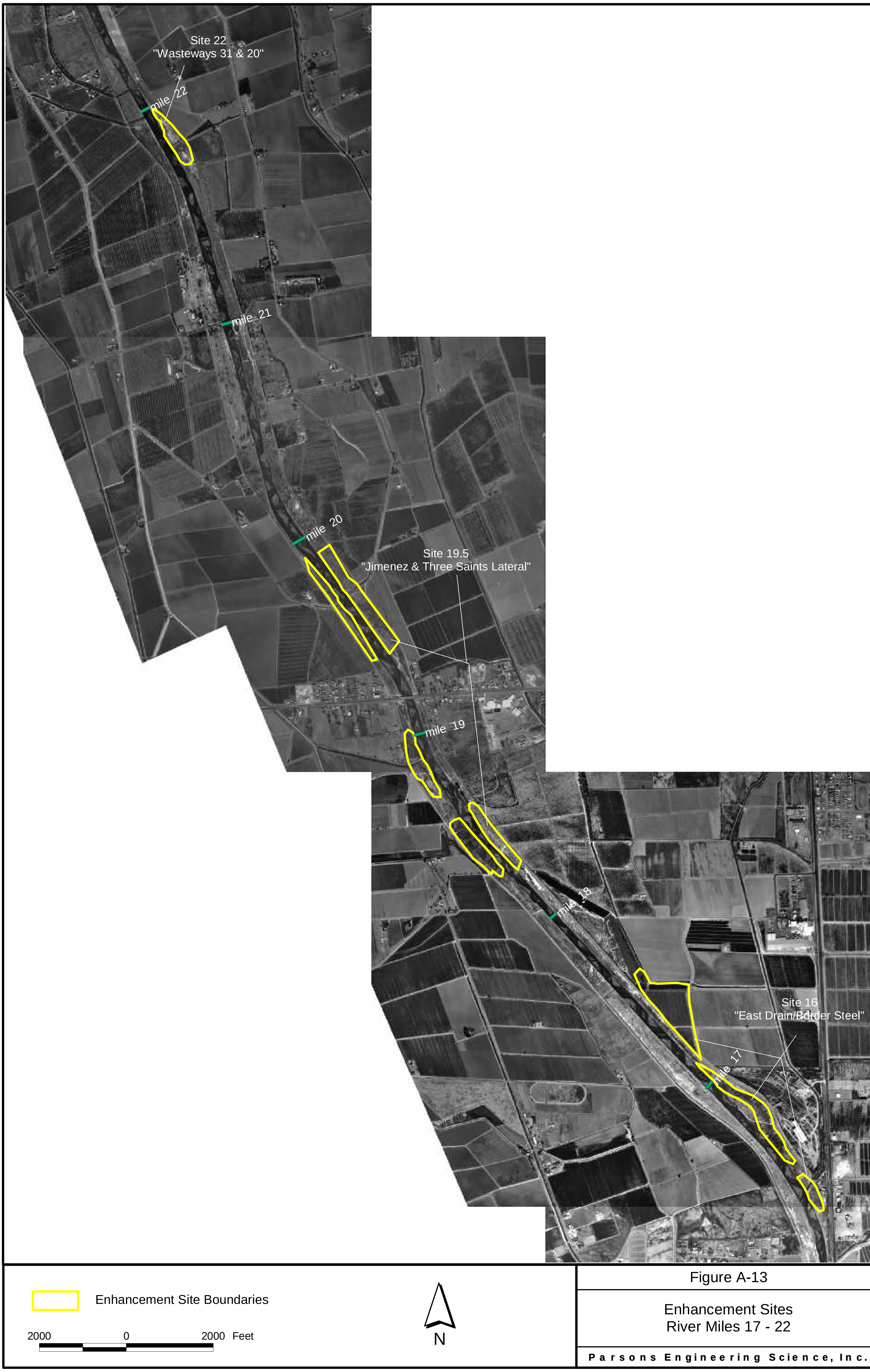


Figure A-13

Enhancement Sites
River Miles 17 - 22

Parsons Engineering Science, Inc.

Enhancement Site Boundaries

2000 0 2000 Feet

N

Figure A-12

Enhancement Sites
River Miles 23 - 28

Parsons Engineering Science, Inc.

Enhancement Site Boundaries

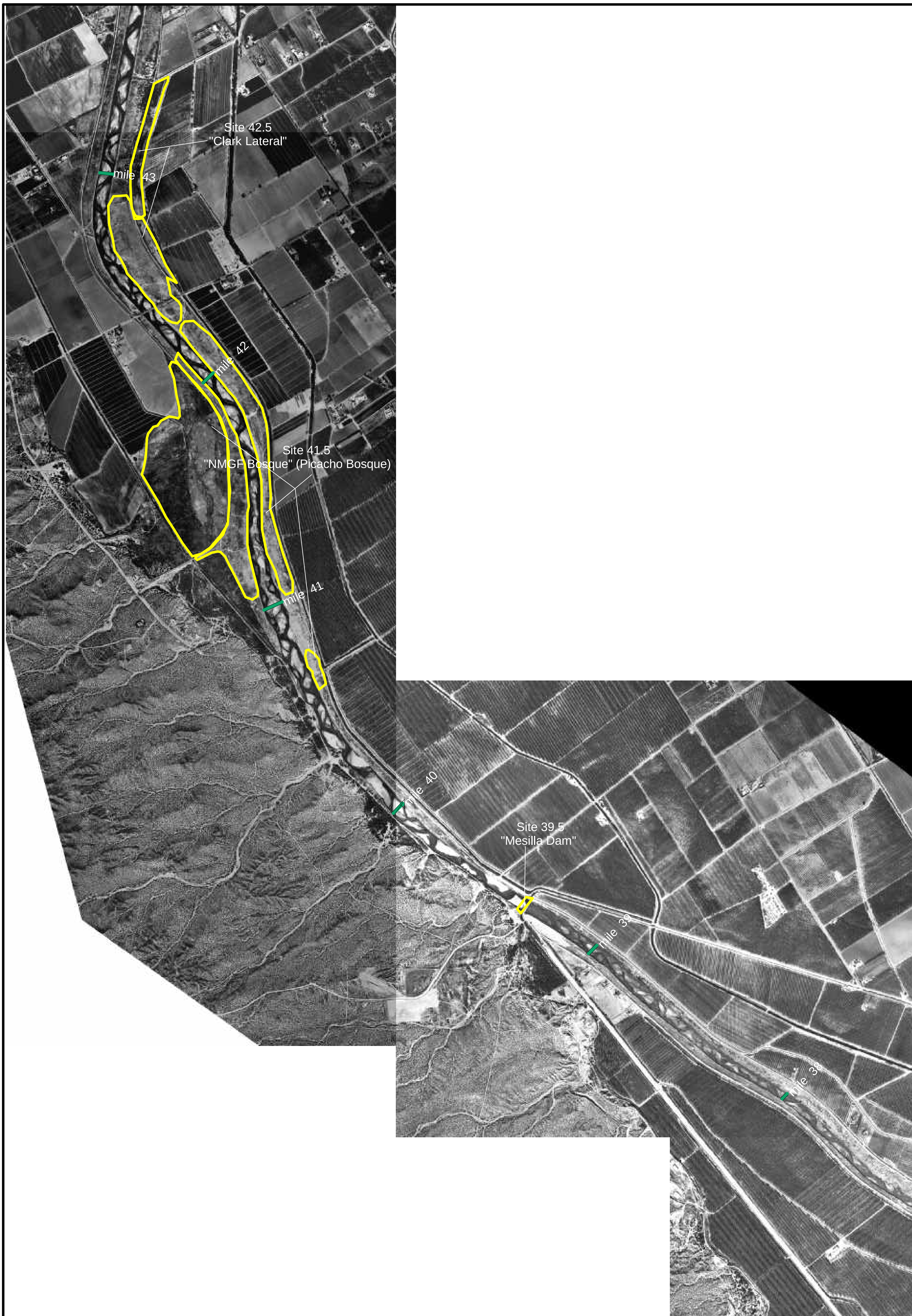
2000 0 2000 Feet

N

Figure A-11

Enhancement Sites
River Miles 29 - 35

Parsons Engineering Science, Inc.



Enhancement Site Boundaries

2000 0 2000 Feet

N

Figure A-10

Enhancement Sites
River Miles 38 - 43

Parsons Engineering Science, Inc.

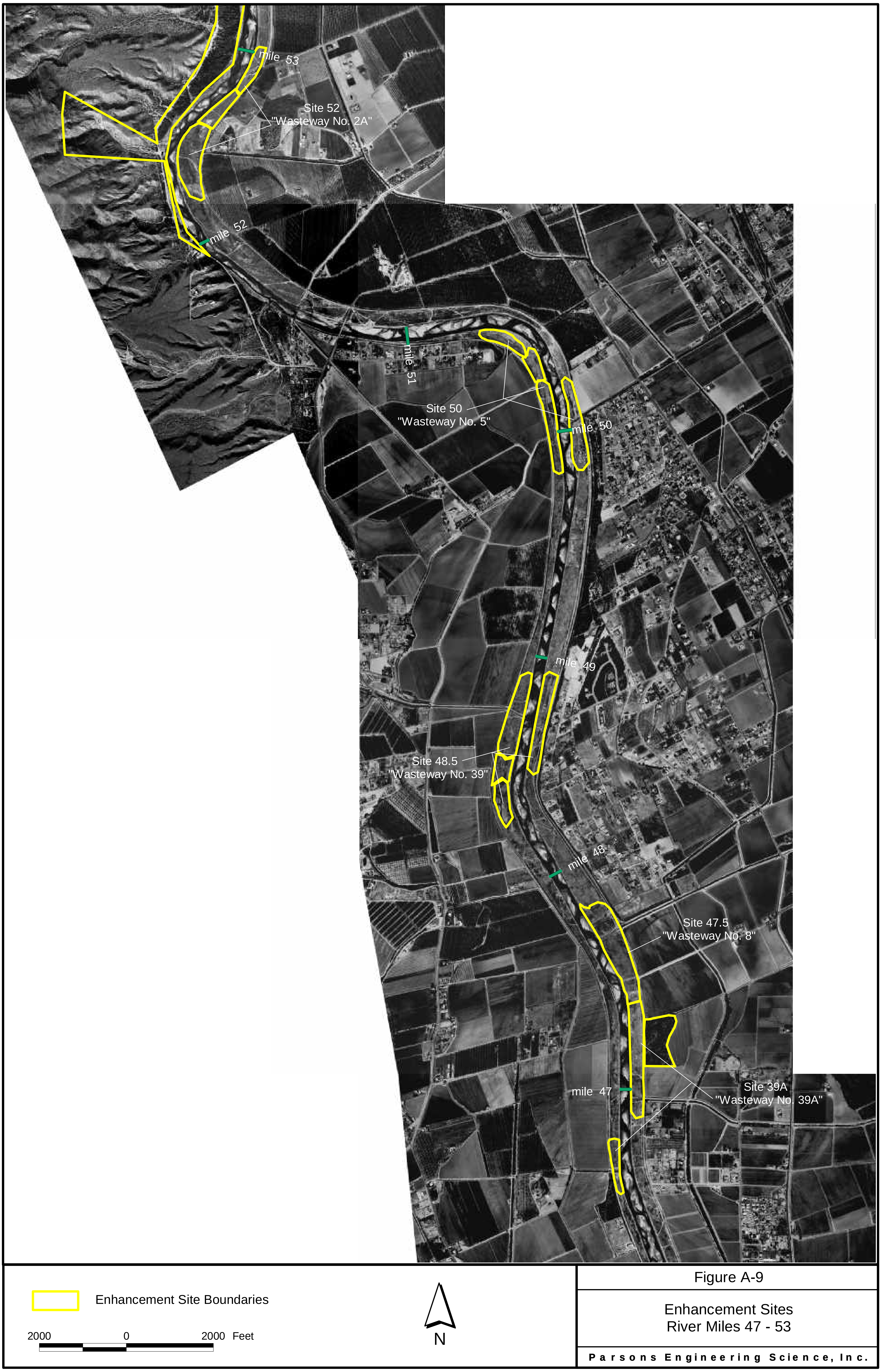


Figure A-9

Enhancement Sites
River Miles 47 - 53

Parsons Engineering Science, Inc.

APPENDIX B
ACTIONS FOR MODIFIED RIVER MANAGEMENT

B.1 Structural Actions for Flood Control

B.1.1 Reconstruct Levees

Increase the height of levees to achieve protection from the design flood along the entire length of the Canalization Project. Levees need to be raised to prevent excessive velocities or encroachment within the 3-foot freeboard along 73 miles of the Project. In addition, a floodwall is needed in the Canutillo area where no levee exists. Levees may also be raised as part of developing riparian habitat within the floodway in order to compensate for the effect of additional vegetation on the flood capacity.

B.1.2 Rehabilitate, Widen, Or Strengthen Levees

Due to the age and method of construction, some parts of the levees may not be structurally capable of withstanding the force of floodwaters during a design flood. Existing levees should be inspected to document structural integrity. Inadequately constructed levees should be upgraded or replaced.

B.1.3 Set Back Levees to Dissipate Floods in the Floodway

This action would consist of moving some levees farther from the river channel to increase the width of the floodplain. This action would likely be implemented in conjunction with other efforts to improve and expand habitats to offset reductions in flood conveyance caused by increased riparian vegetation. These wider levees would allow for a more naturally functioning river and floodplain. This action requires additional land along the river channel that may currently support other uses. Levees that require raising, widening or rehabilitating may be also be candidates for setting back farther from the river channel.

B.1.4 Reduce Runoff Entering River During Rain Storms

Implementation of watershed management practices may serve to reduce the amount and intensity of runoff entering the river during a rain storm. Revegetation of eroded areas will retain soil moisture as well as sediment. Construction of dams on arroyos entering the river would provide both flood protection and a reduction of sediment load.

B.1.5 Install/Modify Grade Control Structures to Prevent Scour

Siphons carrying irrigation water are threatened by erosion of riverbed support material. Permanent structures are needed to control the change in river elevations at these points. The structures would be constructed downstream of the siphons so that water velocities up stream would be reduced. Provisions should also be made to allow for migration of fish to the upstream, low-velocity habitat.

B.2 Environmental Actions For Habitat Improvement

B.2.1 Aquatic (In-Channel Structural Actions)

This section details environmental actions located within the river channel. The purpose of aquatic actions are to increase the diversity and structure of the river channel in order to increase aquatic species diversity and numbers.

Widen Low-Flow Channel

The Canalization Project constructed a low-flow channel designed to carry the maximum expected flow of irrigation water. The resulting channel has a width of about 200 feet and a depth of about 5 feet. Because of the size of the channel, water velocities are too high for fish to effectively propagate. In addition, the relatively high water velocity increases erosion of the bed and banks of the river, which increases the sediment load of the river. Enlarging the low-flow channel width may reduce water velocities enough to provide habitat for fish.

For example, if larger rocks are allowed to remain in the channel at the arroyo mouths, the widening of the channel would compensate for the potential reduction in hydraulic capacity due to rocks in the channel.

Install Additional Rock Groins for Fish Habitat

Rock groins (also known as jetties or spur dikes) consist of large boulders placed in a line at an angle from the river bank and extending into the river channel for less than 10 percent of the channel width. The groins are intended to mimic the hydraulic functions of the arroyo-mouth sediment deposits. The groins impede the downstream flow of water and provide some backwater, pool, and eddy habitats that increase the habitat diversity in the river. This could provide suitable sites for fish to lay eggs and provide cover for fry. The grouping of multiple structures within a reach of the river or near similar habitat may allow fish to move up and down the river over a larger area. Groins do not function effectively during low-flow non-irrigation periods since water recedes into the middle of the channel away from the structure.

Install Additional Vortex Weirs for Fish Habitat

Vortex weirs consist of large boulders placed across the channel in a v-shaped alignment that points upstream. The elevation of the top of the weir is highest at the banks and decreases towards a point in the middle of the channel. The weirs provide some backwater, pool, and eddy habitats that increase the habitat diversity in the river. This could provide suitable sites for fish to lay eggs and provide cover for fry. The grouping of multiple structures within a reach of the river or near similar habitat may allow fish to move over a larger area. Vortex weirs continue to function effectively during low-flow non-irrigation periods.

Modify Water Diversion Features for Fish Habitat

Diversion structures are dams across the river channel with outlets at one or both banks to divert water from the river into irrigation supply canals. The dams prevent movement of fish from downstream to upstream. In addition, fish may be entrained in the diverted water due to its high velocity as it enters the canals. Structures leading downstream from the dam spillways that allow for gradual change in grade that fish could overcome may allow access to more diverse habitat upstream of the dam. The design of the structure would depend on the species targeted.

Canal intake structures that cause fish entrainment could be modified with wider openings or screens to minimize loss of fish.

Canals may also provide wetlands habitat if the channel was widened and made shallower to promote the growth of emergent vegetation.

Instream habitat enhancements included at the diversion dams include placement of large rock, woody debris, or similar material to provide cover and nesting habitat for aquatic species. This would be primarily downstream of the dams. Areas upstream of dams provide more pool-like conditions.

Modify Drain/Spillway River Confluence

The purpose of this action is to create habitat areas similar to the natural oxbows that existed before canalization. Backwater ponds could be excavated in the floodway at sites where a drain or spillway flows into the river. Ponds would provide a site for plantings of native hydrophytic species.

Create Embayments, Backwaters, and Sloughs

Sections of the channel bank may be excavated to create embayments, backwaters, and sloughs. Such still-water and slow-water areas provide slack water refuge and increased diversity in aquatic habitat. These areas also provide stable locations for planting of native riparian vegetation species to provide additional food and cover sources for wildlife. Embayments could be constructed at drain sites that receive water from the drain and are excavated to be open to the river channel. This would provide additional fish habitat and may be less prone to siltation than excavations that receive no flushing flows. Embayments become separated from the river flow during non-irrigation periods.

Modify Channel Maintenance at Arroyos for Fish Habitat

Channel maintenance would be modified to leave larger rocks and boulders at arroyo mouths to provide fish habitat. Such rocky substrate is valuable to fish for spawning areas and to provide cover for young fish.

Increase Sinuosity of River, Create Meanders

Creating meanders would increase the length and width of the river channel while reducing the slope of the channel bed. The result would be closer to natural fluvial processes that existed before the Canalization Project. Water velocities would be lower which would improve the aquatic habitat and reduce erosion of the river bed and banks. The area of aquatic and riparian habitat would increase. This action may only be possible in wide portions of the floodway where meanders would not impinge on the levee structures, or could be done in conjunction with setting back of the levees.

Create Split Channels

Splitting the river channel would result in the creation of an island which could provide additional wildlife habitat, particularly if the island was planted with native riparian vegetation species. The capacity of the floodway to convey the design flood would have to be maintained with the presence of a significant stand of vegetation.

Add Woody Debris for Fish Habitat

Woody debris or similar material can be placed in-stream or along channel banks to provide cover and nesting habitat for aquatic species. Depending on the position, debris can function like rock groins or provide bank stabilization.

B.2.2 Riparian (Non-Structural Actions Within the Floodway)

Modify or Reduce Grazing of Livestock

Currently livestock grazing is allowed on 3,482 acres of land in the Canalization Project area through grazing leases. If not very carefully managed, livestock grazing can have an impact on riparian areas: 1) improper management can result in overgrazing which harms palatable plant species and results in higher weed cover; 2) too many cattle in one area can result in trampling and creation of trails which are susceptible to erosion; 3) over-concentration of cattle can cause deterioration of water quality.

Removal of livestock grazing would remove the risk of overgrazing or other problems due to cattle concentrating in sensitive riparian areas. Vegetation management would need to be implemented to control invasive species such as tamarisk and ensure that desirable native riparian vegetation can become established. Alternative actions could include establishing written, scientifically-based stocking rates and practices, including monitoring, that ensures that vegetation is properly maintained.

Plant Native Riparian Vegetation

This action involves the planting of native species adjacent to the water course. A successful planting program would require knowledge of the ecology of the native species and knowledge of the microenvironment required by desired species. For example, some native species may not be able to establish without periodic flooding or irrigation. Some species may be unable to survive if the water table is too deep. Some riparian species are also sensitive to high soil salinity. Temporary irrigation may be needed to establish some types of vegetation. Removal of invasive, or undesirable vegetation may be needed to ensure that a balanced community of vegetation is established.

Revegetation may be accomplished through seeding, transplants, and pole planting.

- Seeding: Seeds of native plants can be purchased from suppliers or collected from nearby areas and distributed in the floodway. Success of seedling establishment must be accompanied by clearing of competing vegetation, particularly invasive exotic species.
- Transplants: Trees, shrubs, and herbaceous plants may be transplanted into riparian zones and wetlands. A few well established individuals can help contribute seeds to the site as well as providing immediate wildlife benefits.
- Pole planting: This technique involves obtaining long poles, or branches, from live trees and planting them in holes. Cottonwoods and willows are two species that can be successfully grown from poles. Researchers have increased pole planting success through such methods as 1) using very long poles inserted into holes drilled to the groundwater; 2) drilling holes to groundwater, backfilling with soil or mulch, and planting poles on top of the backfilled hole; 3) irrigating poles until their roots have reached groundwater; and 4) promoting root growth with rooting hormone compounds.

An alternative approach that can be used in conjunction with or in place of planting is to allow vegetation to naturally establish. This method is economical and can be as successful as planting programs provided that a desirable mix of plant species can become dominant.

Remove Invasive Vegetation/Fauna (Tamarisk, Cowbirds)

Removal of invasive vegetation and fauna refers to removal of invasive exotic (non-native) species such as salt cedar (tamarisk), Russian olive, Russian thistle, cowbirds, etc.

Removal of salt cedar can be costly and difficult, and the plant often quickly resprouts in areas from which it has been removed. A removal program would ideally be in conjunction with a program to re-establish native species. A healthy native community may be less susceptible to invasion from exotic species. Russian thistle, for example, readily invades cleared areas but is less of a problem in areas that already have good vegetation cover.

The cowbird is a nest parasite, which lays its eggs in the nests of other birds, often removing an egg from the nest for every egg it lays (USFWS 1991). If the parasitized nest is not abandoned, the large cowbird hatchling is thereafter raised by the foster parents without competition. Cowbirds are cited as a factor in the decline of numerous endangered bird species. It is recommended that nest parasitism be studied to ensure it is a significant factor before initiating a cowbird removal program, since cowbird removal techniques (egg removal, trapping, shooting) may also be disruptive to other species. In addition, studies have shown that cowbird removal may only be effective as an ongoing program, and when removal is stopped, the threat from nest parasitism increases again (USFWS 1991).

Establish Additional Green Zones

Green zones are non-mowed areas established by the USIBWC in the floodway of the Canalization Project. The purpose of the green zones is to allow vegetation to grow naturally. Green zones are provisional in nature and are located in areas where the USIBWC has not historically established levees or flood control, or other areas where they would not interfere with flood control (Wilcox 2000). Data will be collected from the green zones in future biological surveys which will help assess their feasibility and their potential habitat value. It is essential that invasive plant species, especially tamarisk, be aggressively managed in green zones. If additional green zones are possible, it would be recommended to locate them in areas where habitat benefits would be maximized. Such areas could include near arroyos, near parks or wildlife preserves, near other habitat enhancement areas, or other sites where wildlife use is likely.

Purchase Land/Development Rights Adjacent to the Floodway

Land and/or development rights can be purchased for similar applications as conservation easements. Open space land could be used to allow zones of natural vegetation to re-establish within or adjacent to the floodway, particularly in areas without levees. Undeveloped land adjacent to the floodway would provide wildlife habitat that would be significantly better quality than the agricultural land that makes up most of the area adjacent to the river corridor. Native vegetation would provide a greater diversity of food and cover for wildlife. Wetland and riparian vegetation would be particularly beneficial to migratory birds and species commonly associated with wetlands such as beavers and raccoons.

Reduce Mowing

Under the current River Management Plan, both floodways and levee slopes in the Canalization Project are mowed at least once a year prior to July 15, except in designated green zones. The purpose of mowing is to control growth of shrubs and trees, especially tamarisk that could, if allowed to grow and create dense stands of trees, affect flow of floodwaters. Tamarisk control is accomplished by annual mowing. The USIBWC would need to evaluate the effects of a reduction in mowing on individual segments of the Project, as some segments may have excess flood capacity while others may not.

Non-mowed areas would be expected to provide better wildlife habitat than mowed areas for several reasons: 1) non-mowed areas would become vegetated with shrubs and trees, which will supplement food and cover for wildlife; 2) denser cover in non-mowed areas would likely allow less encroachment by exotic species and weeds; 3) non-mowed areas help provide a corridor for passage of wildlife from outside the levees to the river. Alternative means of tamarisk control may be implemented to reduce the need for annual mowing.

Reduce Canal Drain Maintenance to One Side Only

This action would involve continuing clearing of vegetation on one side of drains only, rather than both sides as is currently done. This would allow the drain to remain accessible for maintenance actions such as dredging and debris removal, while allowing vegetation to grow on one side to provide a narrow vegetated corridor to the river. Irrigation district cooperation is required for this action.

Monitoring of Enhancements

This is an action that can be applied to any of the actions or alternatives. Monitoring means observing the area and/or collecting data for a period of time after installation of the enhancement to determine if it is achieving its intended functions. Regulatory agencies generally seem to be moving in the direction of requiring monitoring. For example, the USACE requires at least 3 years of monitoring of mitigation wetlands, including submittal of written progress reports.

Restoration of Fluvial Processes

These actions occur adjacent to the floodway (outside the levees); therefore, the USIBWC would have to acquire land or these enhancements would require a cooperating agency, organization, or landowner.

B.2.3 Floodway Expansion

Develop Flood Retention Areas

Flood retention areas could be developed to temporarily capture flood waters, and the waters either held in an impoundment or wetland, or released back into the river after flow rates have dropped below flood levels. Flood retention areas may be developed to restore flood capacity that is reduced by other actions, such as allowing revegetation of the floodway.

Establish Wetlands in Old Oxbows

Establishing wetlands in old oxbows would require a method of conveying water in a controllable fashion through or across the levee into the oxbow; or this action could occur in an area where there are no levees. Alternately, the area could be excavated to bring the soil surface closer to the water table. Establishing a wetland is primarily a matter of establishing wetland hydrology, which allows the area to remain inundated for a sufficient period to allow for hydric soil conditions and hydrophytic vegetation to become established. Wetlands would provide vegetation diversity and habitat for wildlife.

Obtain Flood Easements and Modify Levee Design for Occasional Flooding

This action may be paired with construction of wetlands or flood retention areas, or assumes that land use is such that the land outside the levee could be flooded for a period of time. It is a form of widening the river floodplain in a limited area. Environmental benefits would likely include use of temporarily flooded areas by aquatic and terrestrial species. Levees designated for occasional flooding would have to be hardened with spillway and drain structures to prevent erosion.

Purchase Conservation Easements Adjacent to the Floodway for Habitat

Conservation easements could be purchased to allow zones of natural vegetation to re-establish adjacent to the floodway. These easements could be used to allow native uplands to develop, or in tandem with an action to build wetlands adjacent to the floodway (as discussed previously). Either alternative would provide wildlife habitat that would be significantly better quality than the agricultural land that makes up most of the area adjacent to the river corridor. Native vegetation would provide a greater diversity of food and cover for wildlife. Natural upland vegetation would provide habitat for small mammal and herptile species, which provide a food base for predators and raptors. Wetland vegetation would be particularly beneficial to shorebirds and other species commonly associated with wetlands such as beavers and raccoons.

Construct Treatment Wetlands for Drains into River

Constructed emergent (herbaceous) wetlands adjacent to the floodway could be designed to treat return irrigation water from agricultural lands. Wetlands improve water quality by acting as a sink for sediment and suspended solids. Nutrients are also cycled through wetlands quickly due to their high productivity, and this rate of nutrient cycling can be increased by periodic removal of vegetation from the wetland. Wetlands would also provide vegetation diversity and habitat for wildlife, particularly migrating birds. Irrigation district cooperation is required for this action.

B.2.4 Flow Regime Modification

Multi-Agency Cooperation for River Management

The purpose of this action is to address areas outside the control of the USIBWC, such as water rights, agriculture practices, land use outside the levees, and certain releases of water from reservoirs on the Rio Grande. Many proposed alternatives or actions are outside USIBWC control but could be implemented under a multi-agency management scenario, for example: 1) allowing controlled flood surges or seasonal overbank flooding within the levees; 2) expanding the width of the floodplain (in addition to USIBWC land acquisition); 3) issues related to watershed management; and 4) establishing minimum instream flows.

Establish Instream Flows for Each Segment

This action would require that water rights be obtained in order to establish a minimum instream flow in the river. The purpose would be to maintain designated instream flows for portions of the river to support aquatic habitat and riparian vegetation.

Modify Flow Regime to a More Natural Function

This action could include both alteration of flows and allow more natural geofluvial processes to occur within the floodway. Flow alterations may include 1) minimum instream flows (discussed above); and 2) allowing flood surges and/or overbank flows within the floodway. Geofluvial processes could include: 1) allowing some river meanders to form within floodway; 2) allowing some sandbar development; 3) allowing some natural scouring, undercutting, etc.; and 4) allowing natural formation of sloughs, depressions, and embayments. The modified regime could be based on existing allocations or acquisition of water rights.

Remove Levees to Allow Floods to Dissipate on the Floodplain

The purpose of this action would be to allow the river to return to a natural state where floodwaters would be unconfined. Floods would inundate the river's natural floodplain, then slowly recede, leaving behind pools of standing water in wetlands and low-lying areas. The natural floodplain would be significantly wider than the current USIBWC floodway. Environmental benefits would include more wetlands formation, improved establishment and growth of riparian species, enhancement of groundwater recharge, and more dispersed sediment deposition. Easements or land acquisition would be required.

Point Bar Shave-Downs to Promote Overbank (Over Low-Flow Channel) Flooding

This action would allow overbank flooding within the floodway. Benefits of this action would primarily be to enhance the growth and establishment of natural riparian species, particularly cottonwoods. Cottonwood seeds have a short period of viability and will only germinate on moist soil. Designated point bars would be excavated to an elevation of 1-2 feet above the water level.

B.3 Multi-purpose Management Actions

B.3.1 Erosion Control in Tributary Basins

Install Bank Stabilization for Additional Erosion Control on Arroyos

There are three types of constructed bank stabilization approaches. One approach is to try to stabilize soil by covering it, e.g. with concrete, riprap, or gabion structures.

Concrete and rock structures have good stability, but do not allow much habitat to develop because plant growth is inhibited. There may also be problems with erosion at the edges of the engineered structures.

An alternative approach is to use rails, fences, stabilization jacks, or wooden poles or tree trunks installed in the stream bank. Fences and stabilization jacks help stabilize banks by promoting alluvial deposition on the banks, although they may have limited value unless flows are high enough to allow sediment deposition on banks. Wooden poles or tree trunks can be installed into the bank so they are oriented perpendicular to the bank and extend into the channel. The poles help reduce erosion and promote sediment deposition. They also break down into organic material that enriches the soil and has the advantage of not inhibiting vegetation growth on the banks. Finally, erosion control blankets or similar best management practices (BMP) could be installed on arroyo banks, which have not yet been vegetated, in order to minimize erosion from these areas and sediment loading of the river.

Purchase Conservation Easements for Erosion Control

This action would involve purchasing conservation easements from private landowners and using the land for watershed management. The conservation easements could be used to 1) create buffer zones along the arroyos; 2) build sediment control structures (e.g., in arroyos); and 3) to change land use in areas where sediment loss is currently excessive.

Buffer zones are vegetated areas along watercourses, which help capture sediment and pollutants to keep them from being carried into the stream. Buffer zones also perform the functions of riparian vegetation communities, such as providing wildlife habitat, cover, forage, and shading of the water body. Buffer zones are ideally composed of natural vegetation, and disturbance of soil or vegetation would decrease their effectiveness. Therefore, buffer zones would be feasible only in areas where flood control requirements did not mandate mowing.

Building sediment control structures is another possible use of conservation easement land. This may be recommended for a site where sediment loading is a significant problem.

Change in land use is another potential application of conservation easement land. For example, if a site is currently experiencing excessive erosion and sediment loss, it may be beneficial to purchase an easement that allows it to return to a natural vegetation community.

Establish/Enforce Erosion Control Practices and Regulations

This action could be applied to both areas within USIBWC control and other areas. The USIBWC could develop BMPs for erosion control to be applied to USIBWC-controlled areas within the floodway. Such practices might include 1) reducing mowing frequency and/or increasing mowing height to allow some vegetation recovery; 2) reducing frequency and extent of grading operations within the floodway; 3) mulching and seeding graded areas to minimize erosion; and 4) using tools such as erosion control fabric, silt fences, hay bales, etc. to prevent erosion.

Establishing erosion control practices outside of USIBWC right-of-way would require a cooperative effort among landowners. BLM and NRCS have programs that address erosion control on agricultural land and farmland.

Install Sediment Retention Dams on Arroyos

This action would require land acquisition or cooperation of a private land owner and/or resource agency. Sediment dams could be installed in arroyos, which have been determined to be contributing excessive amounts of sediment to the river. These will also provide a flood control function.

B.3.2 Non-Structural Flood Control Actions

Remove Populations/Infrastructure from Floodplain

This action is to evaluate whether there are locations in the floodplain where populations, public infrastructure, and capital investments can be removed from the floodplain. This action could be a stand-alone action in areas where there are no levees or inadequate levees, or could be done in concert with actions involving removing or setting back levees.

Incorporate Flood Protection in Land Planning

This action could encompass various land use planning issues such as 1) removing populations/infrastructure from the floodplain; 2) building flood retention structures; and 3) stopping development in the flood zone. Land uses outside of the USIBWC right-of-way can influence the flow of floodwaters.

Purchase Flood Easements

This action assumes that land use is such that the land outside the levee could be flooded for a period of time. It is a form of widening the river floodplain in a limited area. Levees designated for occasional flooding would have to be hardened with spillway and drain structures to prevent erosion.

Revise Design Flood

The Canalization Project has been evaluated by the USACE for its ability to control specific maximum flows along its length. The flows were projected from worst case conditions. Land use patterns and structural controls on contributing basins are important factors in determining the projected worst case flow. Numerous sections of the levees are not designed to the flows projected. Conditions within the basins may have changed to make the design flood elevations and flow rates inaccurate. The need to maintain or increase the levee heights may be overstated if the design flood is inaccurate.

Retire Farmlands Adjacent to the Floodway

This is an extension of the proposals to purchase conservation easements or to address land use issues. The approaches would be different depending on whether the water rights of the retired farmland were also made available. Retired farmland could be allowed to revert to natural vegetation for riparian or upland habitat, or could be used as a temporary flood retention area.

B.3.3 Water Conservation/Quality Improvements

Implement Water Conservation Practices

In the Rio Grande Valley, irrigation is almost exclusively flood irrigation. This is a relatively inefficient irrigation practice due to the increased evaporation from the water surface. Water conservation by irrigators would enhance instream flows for aquatic habitat.

Enhance Aquifer Recharge During Wet Years

Aquifer storage and retrieval systems can be utilized to harvest or scalp wet weather flows for future use. The system would require pumps within the river to capture high flows, a pipeline to a holding basin and pumping system where the water would be introduced the water into the aquifer. Treatment of the river water prior to aquifer recharge may be necessary.

Improve Water Quality (Nutrient Loading, Temperature)

Several of the actions will positively affect water quality, e.g., wetlands, more riparian vegetation, preventing overgrazing. Improving water quality will have the affect of creating more suitable habitat for aquatic species and wildlife. Modifying agricultural practices can result in improved water quality.

Control of Non-Point Source Pollution

Non-point source pollution can be controlled through 1) modified farming practices; 2) treating runoff with constructed wetlands; 3) retiring agricultural lands; 4) retiring grazing leases or controlling overgrazing; 5) other treatment systems; and 6) watershed management.

B.3.4 Use of Man-Made Structures

Use Future WTP Reservoirs for Habitat Development

Reservoirs planned for the Sustainable Water Project can be maximized for habitat development by 1) creating aquatic habitat structures; 2) native vegetation plantings around the reservoirs; 3) configuring ponds to maximize habitat, e.g., irregular shoreline shape, various depths of shallows, adjacent wetlands, etc.; and 4) terrestrial habitat enhancements such as installing nesting boxes, leaving brush piles and snags, etc.

Configure Storm Water Ponds as Bird Habitat

Storm water ponds can be maximized for habitat development by 1) creating aquatic habitat structures; 2) planting native vegetation around the ponds, emphasizing species which provide food and cover; and 3) creating a diversity of substrates, e.g., vegetated areas, sandy beaches, and mudflats all serve different habitat functions.

Create Additional Recreational Facilities; Picnic Areas, Paths, Parks

Floodway areas near El Paso could be equipped with paths for recreational or non-motorized vehicle transportation use. Picnic facilities may be developed where the floodway is accessible and parking is available. Vegetation or landscaping for aesthetic purposes may be beneficial. Parkland designated north of El Paso could be incorporated or extended to the floodway.

Designate Preserves and Educational Areas for Public Use

Areas identified for habitat enhancement could be equipped with interpretive trails, and educational markers to help educate visitors about the natural functions of aquatic and riparian habitat. These areas would not be parks for recreation but would be restored habitat with low-impact access features.

APPENDIX C - FLOOD MODELING CROSS SECTION DATA

Table C.1 Revised Manning's "n" Used for Hydraulic Modeling with Environmental Enhancements

	Miles from	Original n			Modified n					Change in X-section*				
Site	**Am. Dam**	**Left Bank**	**Channel**	**Right Bank**	**Left Bank**		**Channel**	**Right Bank**		**L. Levee**	**L. Bank**	**Channel**	**R. Bank**	**R. Levee**
Oxbow	104.7	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**Y**	Y	N
Restoration	104.6	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**Y**	Y	N
	104.5	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**Y**	Y	N
Tripton	103.8	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15				**Y**		
Arroyo	103.7	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**Y**	Y	N
	103.6	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.05	0.15	N	Y	**Y**	Y	N
Trujillo	103.3	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**Y**	Y	N
Arroyo	103.2	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**Y**	Y	N
	103.1	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**Y**	Y	N
	103.0	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**Y**	Y	N
	102.9	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**Y**	Y	N
	102.7	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.4	N	Y	**Y**	Y	N
	102.7	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.4	N	Y	**Y**	Y	N
	102.6	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.4	N	Y	**Y**	Y	N
	102.5	0.035	**0.02**	0.035	0.15	0.15	**0.02**	0.15	0.15	N	Y	**Y**	Y	N
	102.3	0.035	**0.02**	0.035	0.15	0.15	**0.02**	0.15	0.15	N	Y	**Y**	Y	N
	102.2	0.035	**0.02**	0.035	0.15	0.15	**0.02**	0.15	0.15	N	Y	**Y**	Y	N
	102.1	0.035	**0.02**	0.035	0.15	0.15	**0.02**	0.15	0.15	N	Y	**Y**	Y	N
	102.0	0.035	**0.02**	0.035	0.15	0.15	**0.02**	0.15	0.15	N	Y	**Y**	Y	N
	101.9	0.035	**0.02**	0.035	0.15	0.15	**0.02**	0.15	0.15	N	Y	**Y**	Y	N
	101.8	0.035	**0.02**	0.035	0.15	0.15	**0.02**	0.15	0.15	N	Y	**Y**	Y	N
	101.7	0.035	**0.02**	0.035	0.15	0.15	**0.02**	0.15	0.15	N	Y	**Y**	Y	N
Montoya	101.6	0.035	**0.02**	0.035	0.15	0.15	**0.02**	0.15	0.15	N	Y	**Y**	Y	N
Arroyo	101.4	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.15	N	Y	**Y**	Y	N
	101.3	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.15	N	Y	**Y**	Y	N
	101.2	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	101.1	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
Holguin	100.9	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15		N	Y	**Y**	Y	N
Arroyo	100.9	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	100.8	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	N	Y	**Y**	Y	N
	100.7	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	100.6	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
Green/	99.9	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
Tierra	99.8	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
Blanca	99.6	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N

* See Description of Alternatives for details
Y: Cross section was changed
N: No change to cross-section

Table C.1 Revised Manning's "n" Used for Hydraulic Modeling with Environmental Enhancements

	Miles from	Original n			Modified n					Change in X-section*				
Site	**Am. Dam**	**Left Bank**	**Channel**	**Right Bank**	**Left Bank**		**Channel**	**Right Bank**		**L. Levee**	**L. Bank**	**Channel**	**R. Bank**	**R. Levee**
Arroyos	99.5	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	99.4	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	99.4	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	99.2	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	99.1	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	98.9	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	98.8	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	98.7	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	98.6	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	98.5	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.15	0.04	N	Y	**N**	Y	N
Sibley	98.4	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.03	0.04	N	Y	**N**	Y	N
Arroyo	98.3	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	98.2	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.15	N	Y	**N**	Y	N
	98.1	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	98.0	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	97.9	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	97.8	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	97.7	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	97.6	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
Jaralosa	97.5	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
Arroyo	97.4	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	97.3	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	97.3	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	97.2	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	97.1	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	97.0	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	96.9	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	96.8	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	96.6	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	96.5	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	96.3	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	96.2	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
Jaralosa	96.0	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
Arroyo	95.8	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	95.7	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	95.6	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	95.5	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	95.5	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N

* See Description of Alternatives for details
Y: Cross section was changed
N: No change to cross-section

Table C.1 Revised Manning's "n" Used for Hydraulic Modeling with Environmental Enhancements

	Miles from	Original n			Modified n					Change in X-section*				
Site	**Am. Dam**	**Left Bank**	**Channel**	**Right Bank**	**Left Bank**		**Channel**	**Right Bank**		**L. Levee**	**L. Bank**	**Channel**	**R. Bank**	**R. Levee**
	95.4	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	95.3	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	95.2	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	95.1	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	95.0	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	94.9	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	94.8	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	94.7	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	94.6	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
Yeso	94.2	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
Arroyo	94.1	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	94.0	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	93.8	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	93.8	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	93.7	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	93.6	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	93.5	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	93.4	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	93.3	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	93.2	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
Crow	92.6	0.03	**0.02**	0.03	0.04	0.1	**0.02**	0.15		N	Y	**N**	Y	N
Canyou	92.4	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	92.3	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	92.2	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	92.1	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	92.0	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	91.9	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	91.8	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	91.7	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
Crow	91.6	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
Canyou	91.5	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	91.3	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	91.2	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	91.1	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	91.0	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	90.9	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	90.7	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	90.6	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N

* See Description of Alternatives for details
Y: Cross section was changed
N: No change to cross-section

Table C.1 Revised Manning's "n" Used for Hydraulic Modeling with Environmental Enhancements

	Miles from	Original n			Modified n					Change in X-section*				
Site	**Am. Dam**	**Left Bank**	**Channel**	**Right Bank**	**Left Bank**		**Channel**	**Right Bank**		**L. Levee**	**L. Bank**	**Channel**	**R. Bank**	**R. Levee**
	90.5	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	90.4	0.03	**0.02**	0.03	0.04	0.1	**0.02**	0.15		N	Y	**N**	Y	N
Hatch	90.3	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
Siphon	90.2	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	90.2	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	90.2	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	90.2	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	90.2	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.03	N	Y	**N**	Y	N
	90.1	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.03	N	Y	**N**	Y	N
	90.1	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.03	N	Y	**N**	Y	N
	90.1	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.03	N	Y	**N**	Y	N
	89.9	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.03	N	Y	**N**	Y	N
	89.9	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.03	N	Y	**N**	Y	N
Wetlands	88.7	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.05	0.04	N	Y	**N**	Y	N
Unit A	88.6	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.05	0.04	N	Y	**N**	Y	N
	88.5	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.05	0.04	N	Y	**N**	Y	N
	88.4	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.05	0.04	N	Y	**N**	Y	N
	88.4	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.05	0.04	N	Y	**N**	Y	N
Wetlands	87.5	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.05	0.04	N	Y	**N**	Y	N
Unit B	87.4	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.05	0.04	N	Y	**N**	Y	N
	87.3	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.05	0.04	N	Y	**N**	Y	N
	87.2	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.05	0.04	N	Y	**N**	Y	N
	87.1	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.05	0.04	N	Y	**N**	Y	N
Garfield	86.3	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
Drain	86.2	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	86.1	0.03	**0.02**	0.03	0.04	0.05	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	85.9	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
Placitas	85.4	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
Arroyo	85.3	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	85.2	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	85.1	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	85.0	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	84.9	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	84.8	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N

* See Description of Alternatives for details
Y: Cross section was changed
N: No change to cross-section

Table C.1 Revised Manning's "n" Used for Hydraulic Modeling with Environmental Enhancements

	Miles from	Original n			Modified n					Change in X-section*				
Site	**Am. Dam**	**Left Bank**	**Channel**	**Right Bank**	**Left Bank**		**Channel**	**Right Bank**		**L. Levee**	**L. Bank**	**Channel**	**R. Bank**	**R. Levee**
	84.8	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	84.7	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	84.6	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	84.5	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	84.4	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
Remnant	83.2	0.03	**0.02**	0.03	0.15	0.03	**0.02**	0.15	0.15	N	Y	**N**	Y	Y
Bosque/	83.1	0.03	**0.02**	0.03	0.15	0.03	**0.02**	0.15	0.15	N	Y	**N**	Y	Y
Rincon	83.0	0.03	**0.02**	0.03	0.15	0.03	**0.02**	0.15	0.15	N	Y	**N**	Y	Y
	83.0	0.03	**0.02**	0.03	0.15	0.03	**0.02**	0.15	0.15	N	Y	**N**	Y	Y
	82.9	0.03	**0.02**	0.03	0.15	0.03	**0.02**	0.15	0.15	N	Y	**N**	Y	Y
	82.8	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	Y
	82.7	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	Y
	82.6	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	Y
	82.5	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	82.4	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	82.3	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	82.2	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	82.1	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
Angostura	80.9	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
Arroyo	80.8	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	80.7	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	80.6	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	80.5	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
Angostura	80.4	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
Arroyo	80.3	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	80.2	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	80.0	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	79.9	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	79.8	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
Rincon/	78.7	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
Reed	78.5	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
Arroyos	78.4	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	78.3	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	78.2	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	78.1	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
		0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	77.8	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N

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N: No change to cross-section

Table C.1 Revised Manning's "n" Used for Hydraulic Modeling with Environmental Enhancements

	Miles from	Original n			Modified n					Change in X-section*				
Site	**Am. Dam**	**Left Bank**	**Channel**	**Right Bank**	**Left Bank**		**Channel**	**Right Bank**		**L. Levee**	**L. Bank**	**Channel**	**R. Bank**	**R. Levee**
	77.7	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	77.7	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
Bignell	76.7	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.05	0.04	N	Y	**N**	Y	N
Arroyo	76.6	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.05	0.04	N	Y	**N**	Y	N
	76.1	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	76.0	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	75.9	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	75.9	0.03	**0.02**	0.08	0.04	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	75.3	0.03	**0.02**	0.03	0.04	0.05	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	75.2	0.03	**0.02**	0.03	0.04	0.05	**0.02**	0.15	0.04	N	Y	**N**	Y	N
Dead Man's	69.3	0.05	**0.02**	0.03	0.15	0.15	**0.02**	0.05	0.15	N	Y	**N**	Y	N
Curve	69.2	0.05	**0.02**	0.03	0.15	0.15	**0.02**	0.05	0.15	N	Y	**N**	Y	N
	69.1	0.05	**0.02**	0.03	0.15	0.15	**0.02**	0.05	0.15	N	Y	**N**	Y	N
	69.0	0.08	**0.02**	0.03	0.15	0.15	**0.02**	0.05	0.15	N	Y	**N**	Y	N
	68.9	0.08	**0.02**	0.03	0.15	0.15	**0.02**	0.05	0.15	N	Y	**N**	Y	N
	68.8	0.08	**0.02**	0.03	0.15	0.15	**0.02**	0.05	0.15	N	Y	**N**	Y	N
	68.8	0.08	**0.02**	0.03	0.15	0.15	**0.02**	0.05	0.15	N	Y	**N**	Y	N
	68.7	0.08	**0.02**	0.03	0.15	0.15	**0.02**	0.05	0.15	N	Y	**N**	Y	N
Dead Man's	68.6	0.08	**0.02**	0.03	0.15	0.15	**0.02**	0.05	0.15	N	Y	**N**	Y	N
Curve		0.08	**0.02**	0.03	0.15	0.15	**0.02**	0.05	0.15	N	Y	**N**	Y	N
Broad	68.1	0.08	**0.02**	0.08	0.15	0.15	**0.02**	0.04	0.15	N	Y	**N**	Y	N
Canyon	67.9	0.08	**0.02**	0.08	0.15	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	#N/A													
West Side	58.0	0.03	**0.02**	0.035	0.15	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	57.9	0.03	**0.02**	0.035	0.15	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
Levee	57.4	0.03	**0.02**	0.035	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
Setback	57.3	0.03	**0.02**	0.065	0.15	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	57.2	0.03	**0.02**	0.065	0.15	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	57.1	0.03	**0.02**	0.065	0.15	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	56.9	0.03	**0.02**	0.065	0.15	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	56.8	0.03	**0.02**	0.065	0.15	0.15	**0.02**	0.15		N	Y	**N**	Y	N
	56.7	0.03	**0.02**	0.065	0.15	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	56.6	0.03	**0.02**	0.065	0.15	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	56.5	0.03	**0.02**	0.065	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N

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Table C.1 Revised Manning's "n" Used for Hydraulic Modeling with Environmental Enhancements

	Miles from	Original n			Modified n					Change in X-section*				
Site	**Am. Dam**	**Left Bank**	**Channel**	**Right Bank**	**Left Bank**		**Channel**	**Right Bank**		**L. Levee**	**L. Bank**	**Channel**	**R. Bank**	**R. Levee**
Seldon	56.0	0.03	**0.02**	0.05	0.04	0.05	**0.02**	0.15	0.15	N	Y	**N**	Y	N
Drain	55.9	0.03	**0.02**	0.05	0.04	0.05	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	55.7	0.03	**0.02**	0.05	0.04	0.05	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	55.7	0.03	**0.02**	0.05	0.04	0.05	**0.02**	0.15	0.15	N	Y	**N**	Y	N
Channel	54.8	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
Cut	54.7	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	54.6	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	54.5	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	54.5	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	54.4	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	54.2	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	54.2	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	54.1	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	54.0	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	53.9	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
Wasteway	53.0	0.03	**0.02**	0.08	0.04	0.05	**0.02**	0.15	0.15	N	Y	**N**	Y	N
No. 2A	52.9	0.03	**0.02**	0.08	0.04	0.05	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	52.8	0.03	**0.02**	0.08	0.04	0.05	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	52.7	0.03	**0.02**	0.08	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	52.7	0.03	**0.02**	0.08	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	52.6	0.03	**0.02**	0.08	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	52.5	0.03	**0.02**	0.08	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	52.4	0.03	**0.02**	0.035	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	52.3	0.03	**0.02**	0.035	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	50.7	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	50.6	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	50.5	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.15	0.04	N	Y	**N**	Y	N
Wasteway	50.2	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
No. 5	50.1	0.03	**0.02**	0.03	0.04	0.05	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	50.0	0.03	**0.02**	0.03	0.04	0.05	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	49.9	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
Wasteway	48.9	0.03	**0.02**	0.03	0.03	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
No. 39	48.8	0.03	**0.02**	0.03	0.03	0.15	**0.02**	0.05	0.04	N	Y	**N**	Y	N

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N: No change to cross-section

Table C.1 Revised Manning's "n" Used for Hydraulic Modeling with Environmental Enhancements

	Miles from	Original n			Modified n					Change in X-section*				
Site	**Am. Dam**	**Left Bank**	**Channel**	**Right Bank**	**Left Bank**		**Channel**	**Right Bank**		**L. Levee**	**L. Bank**	**Channel**	**R. Bank**	**R. Levee**
	48.7	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.05	0.04	N	Y	**N**	Y	N
	48.6	0.03	**0.02**	0.03	0.03	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	48.4	0.03	**0.02**	0.03	0.03	0.03	**0.02**	0.05	0.04	N	Y	**N**	Y	N
	48.3	0.03	**0.02**	0.03	0.03	0.03	**0.02**	0.05	0.04	N	Y	**N**	Y	N
Wasteway	47.7	0.03	**0.02**	0.03	0.04	0.05	**0.02**	0.03	0.04	N	Y	**N**	Y	N
No. 8	47.6	0.03	**0.02**	0.03	0.04	0.05	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	47.5	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	47.4	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
Wasteway	47.3	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
No. 39A	47.2	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	47.1	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	47.0	0.03	**0.02**	0.03	0.04	0.05	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	46.9	0.03	**0.02**	0.03	0.03	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	46.8	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	46.7	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.05	0.04	N	Y	**N**	Y	N
	46.6	0.03	**0.02**	0.03	0.1	0.03	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	45.5	0.03	**0.02**	0.03	0.04	0.05	**0.02**	0.03	0.1	N	Y	**N**	Y	N
	45.2	0.03	**0.02**	0.03	0.04	0.05	**0.02**	0.03	0.15	N	Y	**N**	Y	N
	44.7	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.03	0.15	N	Y	**N**	Y	N
	44.6	0.03	**0.02**	0.03	0.15	0.05	**0.02**	0.03	0.15	N	Y	**N**	Y	N
	44.5	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.03	0.1	N	Y	**N**	Y	N
	44.4	0.03	**0.02**	0.03	0.15	0.05	**0.02**	0.03	0.1	N	Y	**N**	Y	N
Clark	43.4	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
Lateral	43.3	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	43.2	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	43.1	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.1	N	Y	**N**	Y	N
	43.0	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	42.9	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	42.8	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	42.7	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	42.6	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	42.5	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N

* See Description of Alternatives for details
Y: Cross section was changed
N: No change to cross-section

Table C.1 Revised Manning's "n" Used for Hydraulic Modeling with Environmental Enhancements

	Miles from	Original n			Modified n					Change in X-section*				
Site	**Am. Dam**	**Left Bank**	**Channel**	**Right Bank**	**Left Bank**		**Channel**	**Right Bank**		**L. Levee**	**L. Bank**	**Channel**	**R. Bank**	**R. Levee**
NMGF	42.1	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	42.0	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	42.0	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.05	N	Y	**N**	Y	N
	41.9	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.05	N	Y	**N**	Y	N
	41.8	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.05	N	Y	**N**	Y	N
	41.7	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.05	N	Y	**N**	Y	N
	41.6	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.05	N	Y	**N**	Y	N
	41.5	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.05	N	Y	**N**	Y	N
	41.4	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.05	N	Y	**N**	Y	N
	41.3	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.05	N	Y	**N**	Y	N
	41.2	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	40.7	0.03	**0.02**	0.035	0.15	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	40.6	0.03	**0.02**	0.035	0.15	0.05	**0.02**	0.15	0.15	N	Y	**N**	Y	N
Pole Planting	34.9	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.15	N	Y	**N**	Y	N
Area	34.8	0.03	**0.02**	0.03	0.04	0.05	**0.02**	0.03	0.15	N	Y	**N**	Y	N
	34.6	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.15	N	Y	**N**	Y	N
	34.5	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.15	N	Y	**N**	Y	N
	34.4	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.15	N	Y	**N**	Y	N
	34.3	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.15	N	Y	**N**	Y	N
	34.2	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.15	N	Y	**N**	Y	N
	34.1	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.15	N	Y	**N**	Y	N
	34.0	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.15	N	Y	**N**	Y	N
	33.1	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.05	0.15	N	Y	**N**	Y	N
	32.9	0.03	**0.02**	0.03	0.04	0.05	**0.02**	0.03	0.15	N	Y	**N**	Y	N
	32.3	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.05	0.04	N	Y	**N**	Y	N
	31.9	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	31.8	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	31.7	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	31.6	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	31.5	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
Wasteway 18	29.8	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N

* See Description of Alternatives for details
Y: Cross section was changed
N: No change to cross-section

Table C.1 Revised Manning's "n" Used for Hydraulic Modeling with Environmental Enhancements

	Miles from	Original n			Modified n					Change in X-section*				
Site	**Am. Dam**	**Left Bank**	**Channel**	**Right Bank**	**Left Bank**		**Channel**	**Right Bank**		**L. Levee**	**L. Bank**	**Channel**	**R. Bank**	**R. Levee**
	29.7	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	29.6	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	29.5	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	29.5	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	29.4	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
	29.3	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.03	0.04	N	Y	**N**	Y	N
Old	28.4	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
Channel	28.3	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	28.2	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
Old	28.1	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
Channel	28.0	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	27.9	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
		0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
Del Rio	27.3	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.15	0.15	N	Y	**N**	Y	N
Drain	27.2	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.15	0.04	N	Y	**N**	Y	Y
	27.1	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.15	0.15	N	Y	**N**	Y	Y
	26.9	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.15	0.15	N	Y	**N**	Y	Y
	26.8	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	Y
	26.7	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	26.6	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
Wasteway	26.1	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
19	26.0	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	25.9	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	25.9	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	25.8	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	23.4	0.03	**0.02**	0.03	0.04	0.05	**0.02**	0.03	0.04	N	Y	**N**	Y	N
Wasteway 31	22.1	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.05	0.04	N	Y	**N**	Y	N
&	22.0	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.05	0.04	N	Y	**N**	Y	N
Wasteway 20	21.9	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	21.8	0.03	**0.02**	0.03	0.04	0.05	**0.02**	0.15	0.04	N	Y	**N**	Y	N
Jimenez	19.7	0.03	**0.02**	0.03	0.04	0.05	**0.02**	0.05	0.04	N	Y	**N**	Y	N
and	19.6	0.03	**0.02**	0.03	0.04	0.05	**0.02**	0.05	0.02	N	Y	**N**	Y	N
Three														
Saints	18.9	0.03	**0.02**	0.03	0.15	0.03	**0.02**	0.15	0.1	N	Y	**N**	Y	N

* See Description of Alternatives for details
Y: Cross section was changed
N: No change to cross-section

Table C.1 Revised Manning's "n" Used for Hydraulic Modeling with Environmental Enhancements

	Miles from	Original n			Modified n					Change in X-section*				
Site	**Am. Dam**	**Left Bank**	**Channel**	**Right Bank**	**Left Bank**		**Channel**	**Right Bank**		**L. Levee**	**L. Bank**	**Channel**	**R. Bank**	**R. Levee**
Lateral	18.8	0.03	**0.02**	0.03	0.15	0.03	**0.02**	0.05	0.04	N	Y	**N**	Y	N
	18.6	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.05	0.04	N	Y	**N**	Y	N
	18.5	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.05	0.04	N	Y	**N**	Y	N
	18.4	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.05	0.04	N	Y	**N**	Y	N
	18.3	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	18.2	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
Jimenez	18.1	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
and	18.0	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	Y	Y	**N**	Y	N
Three	17.9	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	Y	Y	**N**	Y	N
Saints	17.8	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	Y	Y	**N**	Y	N
Lateral	17.7	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	Y	Y	**N**	Y	N
	17.6	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	Y	Y	**N**	Y	N
East	17.5	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
Drain	17.4	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	17.3	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	17.2	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	17.1	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	17.0	0.03	**0.02**	0.03	0.04	0.05	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	17.0	0.03	**0.02**	0.03	0.1	0.05	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	16.9	0.03	**0.02**	0.03	0.1	0.05	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	16.8	0.03	**0.02**	0.03	0.1	0.05	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	16.7	0.03	**0.02**	0.03	0.1	0.05	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	16.6	0.03	**0.02**	0.03	0.1	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	16.5	0.03	**0.02**	0.03	0.1	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	16.4	0.03	**0.02**	0.03	0.1	0.05	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	16.2	0.03	**0.02**	0.03	0.1	0.15	**0.02**	0.15	0.04	N	Y	**N**	Y	N
	14.5	0.03	**0.02**	0.03	0.04	0.05	**0.02**	0.03	0.03	N	Y	**N**	Y	N
	13.8	0.03	**0.02**	0.03	0.03	0.03	**0.02**	0.05	0.03	N	Y	**N**	Y	N
	13.2	0.03	**0.02**	0.03	0.15	0.05	**0.02**	0.05	0.15	N	Y	**N**	Y	N
	11.7	0.03	**0.02**	0.03	0.1	0.15	**0.02**	0.05	0.04	N	Y	**N**	Y	N
	11.4	0.03	**0.02**	0.03	0.15	0.03	**0.02**	0.05	0.04	N	Y	**N**	Y	N
Wasteway	11.0	0.03	**0.02**	0.03	0.15	0.05	**0.02**	0.03	0.04	N	Y	**N**	Y	N

* See Description of Alternatives for details
Y: Cross section was changed
N: No change to cross-section

Table C.1 Revised Manning's "n" Used for Hydraulic Modeling with Environmental Enhancements

	Miles from	Original n			Modified n					Change in X-section*				
Site	**Am. Dam**	**Left Bank**	**Channel**	**Right Bank**	**Left Bank**		**Channel**	**Right Bank**		**L. Levee**	**L. Bank**	**Channel**	**R. Bank**	**R. Levee**
34	10.9	0.03	**0.02**	0.03	0.1	0.03	**0.02**	0.05	0.04	N	Y	**N**	Y	N
	10.3	0.03	**0.02**	0.03	0.15	0.03	**0.02**	0.05	0.04	N	Y	**N**	Y	N
	9.8	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.05	0.04	N	Y	**N**	Y	N
Wasteway	9.3	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.05	0.04	N	Y	**N**	Y	N
35	9.2	0.03	**0.02**	0.03	0.04	0.03	**0.02**	0.05	0.04	N	Y	**N**	Y	N
New	7.1	0.03	**0.02**	0.03	0.03	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
Mexas	7.0	0.03	**0.02**	0.03	0.03	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
Drain	6.9	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	6.8	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
Sunland	5.9	0.03	**0.02**	0.03	0.03	0.05	**0.02**	0.15	0.1	N	Y	**N**	Y	N
Park	5.8	0.03	**0.02**	0.03	0.03	0.15	**0.02**	0.15	0.1	N	Y	**N**	Y	N
	5.7	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.1	N	Y	**N**	Y	N
	5.6	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.1	N	Y	**N**	Y	N
	5.5	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.1	N	Y	**N**	Y	N
	5.4	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.1	N	Y	**N**	Y	N
	5.3	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.1	N	Y	**N**	Y	N
	5.2	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.1	N	Y	**N**	Y	N
	5.1	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.1	N	Y	**N**	Y	N
Cotton	4.5	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
Wood	4.5	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
Grove	4.4	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	4.3	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	4.1	0.03	**0.02**	0.03	0.04	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	4.0	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	3.9	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
	3.8	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N
Anapra	3.3	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.1	N	Y	**N**	Y	N
Bridge	3.2	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.1	N	Y	**N**	Y	N
	3.1	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.1	N	Y	**N**	Y	N
	3.0	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.1	N	Y	**N**	Y	N
	2.9	0.03	**0.02**	0.03	0.15	0.15	**0.02**	0.15	0.15	N	Y	**N**	Y	N

* See Description of Alternatives for details
Y: Cross section was changed
N: No change to cross-section

Table C.2 Hydraulic Modeling Results for Cross Sections

	Miles North of American Dam	Cross Section Number	Station Number	West Side, (Right Looking Downstream) Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	East Side, (Left Looking Downstream) Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)	
Upper Rincon Management Unit	105.4	1055	5567+00	10.9			4139.4			14.0	2.2	Levee Freeboard
	105.4	1054	5565+00	11.9		2.1	4138.9	2.3		11.3	2.2	<3 ft and > 1 ft
	105.3	1053	5560+00	13.4			4137.3			12.4	1.1	<=1 ft and > 0 ft
	105.2	1052	5555+00	15.2			4136.7			12.6	0.9	<= 0 ft
	105.1	1051	5550+00	12.5			4136.1			12.3	0.6	
	105.0	1050	5545+00	12.0			4135.6			12.1	0.7	Edge Velocity
	104.9	1049	5540+00	11.7			4135.3			13.8	0.8	<=4 ft/s and > 3 ft/s
	104.8	1048	5535+00	10.9			4134.5			15.0	0.5	> 4 ft/s
Oxbow Restoration Site	104.7	1047.0	5530+00	8.0			4134.0			10.6	0.0	
	104.6	1046.0	5525+00	12.4		3.2	4134.2			8.9	0.3	Water Surface Elev. Change
	104.5	1045.0	5520+00	12.0			4133.8			6.2	0.1	decrease
	104.5	1044.0	5515+00	12.8			4133.6			12.8	0.2	<2 ft and >=0 ft increase
Arrey Highway Bridge	104.4	1043.0	5510+00	12.8			4133.5	0.2		14.2	0.1	>= 2 ft increase
	104.3	1042.50		12.7		0.3	4133.2	0.2		11.7	-0.2	
	104.3	1042.40		12.8		0.3	4133.1	0.3		11.8	-0.3	
	104.3	1042.30		12.8		0.3	4133.1	0.3		11.8	-0.3	
	104.3	1042.20		12.8		0.3	4133.1	0.2		11.8	0.2	
	104.2	1042.0	5500+00	10.0		0.4	4133.0			12.9	0.2	
	104.1	1041.0	5495+00	10.2			4133.0			12.1	0.1	
Tripton Arroyo Site	103.8	1040.0	5480+00	10.6			4132.7	0.2		7.0	0.2	
	103.7	1039.0	5475+00	10.0			4132.7	0.3		6.3	0.4	
	103.6	1038.0	5470+00	9.0			4132.4			3.8	0.2	
	103.5	1037.0	5465+00	9.3			4132.0			4.8	0.0	
	103.4	1036.0	5460+00	9.8			4131.9	0.2		8.3	0.1	
Trujillo Arroyo Site	103.3	1035.0	5455+00	3.8			4131.6	0.2		1.6	0.0	
	103.2	1034.0	5450+00	3.1			4131.5	0.4		2.6	-0.1	
	103.1	1033.0	5445+00	1.5		0.1	4131.3			9.7	0.5	
	103.0	1032.0	5440+00	0.9		0.3	4131.0	0.1		8.8	0.1	
	102.9	1031.0	5435+00	3.9		0.3	4130.8			9.1	0.2	
	102.7	1030.0	5425+00	8.5		0.2	4130.7			3.3	0.6	
	102.7	1029.0	5420+00	8.2		0.3	4130.6			4.0	0.7	
	102.6	1028.0	5415+00	7.4		0.0	4130.6	0.1		3.6	1.0	
	102.5	1027.0		2.6		0.3	4130.1	0.1		6.9	0.7	Levee Freeboard
	102.3	1026.0	5400+00	3.4		0.4	4129.6	0.2		0.5	0.3	<3 ft and > 1 ft

Table C.2 Hydraulic Modeling Results for Cross Sections

				West Side, (Right Looking Downstream)				East Side, (Left Looking Downstream)				
	Miles North of American Dam	Cross Section Number	Station Number	Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)	
	102.2	1025.0	5395+00	3.4		0.1	4129.6	0.1		6.9	0.3	<=1 ft and > 0 ft
	102.1	1024.0	5390+00	3.5		0.2	4129.4	0.3		5.3	0.1	<= 0 ft
	102.0	1023.0	5385+00	2.3		0.3	4129.4	0.3		4.6	0.4	
	101.9	1022.0	5380+00	1.9		0.4	4129.2	0.2		5.5	0.3	**Edge Velocity**
	101.8	1021.0	5375+00	1.8		0.3	4129.0			3.0	0.3	<=4 ft/s and > 3 ft/s
	101.7	1020.0	5370+00	1.5		0.3	4128.9	0.3		3.8	2.6	> 4 ft/s
Montoya Arroyo Site	101.6	1019.0	5365+00	0.4		0.7	4128.5	0.9		3.2	1.9	
	101.4	1018.0	5355+00	1.6		2.7	4128.4	0.2		1.3	1.8	**Water Surface Elev. Change**
	101.3	1017.0	5350+00	1.2		0.4	4127.6	0.4		-0.4	1.0	decrease
	101.2	1016.0	5345+00	5.0			4127.1	0.6		3.0	0.8	<2 ft and >=0 ft increase
	101.1	1015.0	5340+00	2.0			4127.0	0.7		1.7	0.9	>= 2 ft increase
	100.9	1014.0	5330+14.9	2.3		0.5	4126.5	0.7		0.5	0.5	
Holguin Arroyo Site	100.9	1013.0	5325+00	1.3		1.2	4126.6	0.1		7.8	1.0	
	100.8	1012.0	5319+79.9	1.6		1.7	4126.7	0.2		26.6	1.4	
	100.7	1011.0	5314+77.2	2.6		0.5	4125.9	0.3		-0.1	0.6	
	100.6	1010.0	5310+00	1.0		0.3	4125.6	0.4		23.9	0.3	
	100.5	1009.0	5305+00	2.0		0.3	4125.7	0.8		87.4	0.5	
	100.4	1008.0	5300+00	2.0		0.6	4125.7	0.5		63.5	0.5	
	100.3	1007.0	5295+00	1.0		0.4	4125.7	0.2		32.2	0.6	
Garfield Flume	100.2	1006.0	5290+00	7.0		0.5	4125.4	0.4		5.7	0.3	
	100.1	1005.50	5286+46.2612	3.5		0.5	4125.2	0.2		3.6	0.1	
Garfield Highway Bridge		1005.40		3.6		0.6	4125.1	0.3		3.7	0.1	
		1005.30		3.6		0.6	4125.1	0.3		3.7	0.1	
		1005.20		3.6		0.5	4125.1	0.2		3.7	0.1	
Green / Tierra Blanca Creek Site	99.9	1005.0	5275+00	3.5		0.8	4125.1	0.5		1.2	4.8	
	99.8	1004.0	5270+00	4.1		0.5	4121.2	0.4		2.8	0.6	
	99.6	1003.0	5260+00	3.7		0.7	4120.9	0.3		3.3	0.6	
	99.5	1002.0	5255+00	3.9		1.0	4121.1	0.3		1.7	0.9	
	99.4	1001.0	5250+00	3.6		0.6	4120.0	0.5		1.1	0.3	
	99.4	1000.0	5247+56.9	3.5		0.3	4120.7	1.9		0.1	1.8	
	99.2	999.0	5240+00	1.0		0.2	4120.6	1.7		2.0	1.9	**Levee Freeboard**
	99.1	998.0	5230+00	0.5		0.0	4119.3	0.5		0.7	0.6	<3 ft and > 1 ft
	98.9	997.0	5220+00	1.9		0.4	4119.1	1.3		1.7	0.5	<=1 ft and > 0 ft
	98.8	996.0	5215+00	1.4		0.4	4118.4	0.4		4.2	-0.1	<= 0 ft

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Table C.2 Hydraulic Modeling Results for Cross Sections

				West Side, (Right Looking Downstream)				East Side, (Left Looking Downstream)				
	Miles North of American Dam	Cross Section Number	Station Number	Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)	
	98.7	995.0	5210+00	0.9		0.3	4118.7	1.3		2.9	0.1	
	98.6	994.0	5205+00	4.5		0.4	4118.5	1.2		3.3	0.0	Edge Velocity
	98.5	993.0	5200+00	5.3		0.5	4118.5	1.0		2.1	0.4	<=4 ft/s and > 3 ft/s
Sibley Arroyo Point Bar Site	98.4	992.0	5195+00	12.0		0.7	4118.6	1.0		1.4	0.9	> 4 ft/s
	98.3	991.0	5190+00	10.2		0.9	4118.3	0.3		1.0	4.0	
	98.2	990.0	5185+00	8.3		0.8	4117.8	0.3		1.1	3.6	Water Surface Elev. Change
Sibley Arroyo	98.1	989.0	5180+00	7.1		0.3	4114.9	0.1		3.2	1.5	decrease
	98.0	988.0	5175+00	7.3			4115.1	0.3		2.9	2.2	<2 ft and >=0 ft increase
	97.9	987.0	5170+00	15.3		0.6	4113.5	0.8		2.4	1.0	>= 2 ft increase
	97.8	986.0	5165+00	27.8		0.7	4113.0	0.7		0.7	0.6	
	97.7	985.0	5160+00	47.6		0.7	4112.9	0.1		3.1	1.3	
	97.6	984.0	5155+00	22.5		1.0	4112.1			4.4	0.7	
Jaralosa Arroyo Site	97.5	983.0	5150+00	13.9		0.6	4111.6	0.2		6.4	0.4	
	97.4	982.0	5145+00	2.8		0.5	4111.3	0.3		6.7	0.8	
	97.3	981.0	5140+00	2.6		0.6	4110.8	0.2		7.4	0.4	
	97.3	980.0	5135+00	2.4		0.8	4109.8	0.1		8.0	-0.8	
	97.2	979.0	5130+00	2.9		0.3	4109.7	0.5		8.1	-0.5	
	97.1	978.0	5125+00	3.0		0.6	4109.4	0.4		7.4	-0.3	
	97.0	977.0	5120+00	1.2		4.0	4109.6	0.4		8.0	0.9	
	96.9	976.0	5115+00	2.5		3.8	4109.4	0.3		7.7	2.3	
	96.8	975.0	5110+00	7.7		3.8	4109.3	0.2		7.2	2.6	
Barrenda Creek	96.6	974.0	5100+00	3.2		0.2	4107.1			8.6	1.2	
	96.5	973.0	5095+00	3.1		0.4	4106.8	0.1		9.0	1.2	
	96.3	972.0	5085+00	1.5		0.1	4106.1	0.2		8.5	1.8	
	96.2	971.0	5080+00	3.8			4105.8	0.2		8.2	1.9	
	96.0	970.0	5070+00	3.0		0.1	4104.6	0.2		8.4	0.3	
	95.8	969.0	5060+00	6.2		0.4	4104.0			7.6	0.2	
	95.7	968.0	5055+00	6.4		0.5	4103.9	0.4		7.1	0.9	
	95.6	967.0	5050+00	8.7		0.1	4103.4	0.3		7.6	0.6	Levee Freeboard
	95.5	966.0	5045+00	16.9		0.3	4103.3	0.2		6.8	0.8	<3 ft and > 1 ft
	95.5	965.0	5040+00	12.6		0.6	4102.7	0.3		7.3	0.5	<=1 ft and > 0 ft
	95.4	964.0	5035+00	24.8		0.5	4102.6	0.2		6.9	0.8	<= 0 ft
	95.3	963.0	5030+00	28.7		0.5	4102.1	0.2		7.5	0.6	
	95.2	962.0	5025+00	23.9		0.6	4101.8	0.2		7.6	0.9	Edge Velocity

Table C.2 Hydraulic Modeling Results for Cross Sections

	Miles North of American Dam	Cross Section Number	Station Number	West Side, (Right Looking Downstream) Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	East Side, (Left Looking Downstream) Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)	
	95.1	961.0	5020+00	16.7		0.8	4101.1	0.2		8.1	0.4	<=4 ft/s and > 3 ft/s
	95.0	960.0	5015+00	8.2		0.4	4101.1	0.2		7.6	1.1	> 4 ft/s
	94.9	959.0	5010+00	6.6			4099.8	0.5		8.7	0.1	
	94.8	958.0	5005+00	5.3			4099.7	0.3		8.2	0.2	Water Surface Elev. Change
	94.7	957.0	5002+50	4.9			4099.5	0.2		8.2	0.2	decrease
	94.6	956.0	4995+00	7.8		0.6	4099.2	0.2		8.6	0.4	<2 ft and >=0 ft increase
	94.5	955	4990+00	9.7		3.2	4098.9	0.8		7.7	0.3	>= 2 ft increase
	94.4	954	4985+00	8.9		2.3	4098.7			7.3	0.3	
	94.3	953	4980+00	7.9		2.2	4098.5	0.9		7.1	0.1	
Yeso Arroyo Site	94.2	952.0	4975+00	17.2		1.7	4098.3	0.2		7.0	0.0	
Remnant Bosque	94.1	951.0	4970+00	17.8		0.8	4098.0	0.2		7.6	0.4	
	94.0	950.0	4965+00	13.7		0.6	4097.4	0.1		8.4	1.7	
	93.8	949.0	4955+00	15.3			4095.6	0.2		9.6	-0.5	
	93.8	948.0	4950+00	18.3		0.7	4095.6	0.3		9.4	-0.2	
	93.7	947.0	4945+00	6.3		0.2	4096.0	3.2		8.6	0.1	
	93.6	946.0	4940+00	5.7		0.1	4096.0	2.4		7.1	0.2	
	93.5	945.0	4935+00	5.6		0.1	4096.0	2.1		6.1	0.9	
	93.4	944.0	4930+00	6.0			4094.6	0.6		6.4	1.6	
	93.3	943.0	4925+00	7.5			4092.8	0.1		7.8	-0.1	
	93.2	942.0	4920+00	8.8		0.5	4092.4			9.1	-0.5	
	93.1	941	4915+00	8.0		3.0	4092.3	0.4		8.3	-0.6	
	93.0	940.0	4910+00	18.0		2.4	4092.4	1.3		6.9	-0.3	
	92.9	939	4904+40.8	30.0		2.8	4092.1	1.1		7.9	-0.2	
	92.8	938	4900+00	45.4			4091.6			8.4	-0.4	
	92.7	937	4895+00	22.8		2.4	4091.2			8.2	-0.5	
Crow Canyon Site	92.6	936.0	4890+00	8.6		0.4	4090.5	0.9		8.1	-0.3	
Arroyo Cuervo	92.4	935.0	4880+00	4.4			4088.8			9.2	-1.7	Levee Freeboard
	92.3	934.0	4875+00	4.3			4088.3			9.5	-1.9	<3 ft and > 1 ft
	92.2	933.0	4870+00	11.2			4087.5			10.1	-2.4	<=1 ft and > 0 ft
	92.1	932.0	4865+00	12.6			4086.0			11.7	-3.4	<= 0 ft
	92.0	931.0	4860+00	9.9			4086.7	5.7		10.1	-2.4	
	91.9	930.0	4850+00	3.4			4086.6	3.8		10.0	-0.8	Edge Velocity
	91.8	929.0	4845+00	3.4			4086.6	3.1		8.0	0.6	<=4 ft/s and > 3 ft/s
	91.7	928.0	4840+00	2.4			4086.4	3.7		7.5	1.1	> 4 ft/s

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Table C.2 Hydraulic Modeling Results for Cross Sections

				West Side, (Right Looking Downstream)				East Side, (Left Looking Downstream)				
	Miles North of American Dam	Cross Section Number	Station Number	Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)	
	91.6	927.0	4835+00	4.2			4086.4	2.9		6.2	2.2	
	91.5	926.0	4830+00	4.8		0.2	4086.4	2.5		6.2	2.1	Water Surface Elev. Change
	91.3	925.0	4820+00	6.6		0.5	4085.5	0.4		5.6	1.3	decrease
	91.2	924.0	4815+00	5.7		0.5	4085.3	0.5		4.9	2.0	<2 ft and >=0 ft increase
	91.1	923.0	4810+00	4.0		0.3	4085.0	0.4		5.2	2.5	>= 2 ft increase
	91.0	922.0	4805+00	5.6		0.4	4084.8	0.4		5.0	2.3	
	90.9	921.0	4800+00	3.8		0.5	4084.4	0.5		4.6	2.5	
	90.7	920.0	4790+00	23.8		0.6	4081.3	1.1		7.5	-0.4	
	90.6	919.0	4785+00	18.4		0.3	4082.0	0.6		6.2	0.8	
	90.5	918.0	4780+00	36.6		0.3	4081.4	0.6		7.2	2.0	
	90.4	917.0	4775+00	2.5		0.2	4079.6	1.1		8.5	0.6	
Hatch Siphon Site	90.3	916.0	4770+00	4.1		0.1	4079.0	0.7		8.1	1.2	
	90.2	915.0	4765+00	5.5			4077.9	0.8		8.3	0.3	
	90.2	914.0	4763+98.5	5.7			4077.8	0.8		9.1	0.9	
	90.2	913.0	4763+27.6	6.4			4077.3	0.8		9.1	0.7	
	90.2	912.0		7.0			4076.7	1.0		9.1	0.1	
	90.2	911.0	4760+00	7.0		0.4	4075.8	0.3		10.0	0.1	
	90.1	910.0	4758+94.7	6.8		0.3	4075.8	0.2		10.0	0.1	
	90.1	909.0	4757+09.5	6.3		0.3	4075.5	0.5		10.3	0.0	
	90.1	908.0	4754+71.2	6.7		0.2	4075.0	0.6		10.3	-0.1	
	89.9	907.0	4747+20.4	6.8		0.3	4074.2			10.2	0.0	
	89.9	906.0	4745+00	6.2		0.4	4074.0			10.8	-0.1	
Upper Rincon Management Unit	89.8	905	4740+00	9.2		2.3	4073.9			10.2	0.0	
Lower Rincon Management Unit	89.7	904	4735+00	10.4		2.1	4073.6			11.0	0.0	
	89.6	903	4730+00	7.0		2.5	4072.8			11.5	0.0	Levee Freeboard
	89.5	902	4725+00	2.2		1.0	4072.8			10.8	0.0	<3 ft and > 1 ft
	89.4	901	4720+00	9.6		0.3	4072.4	2.4		9.8	0.0	<=1 ft and > 0 ft
	89.3	900	4715+00	8.8		0.6	4072.0	2.2		10.0	0.0	<= 0 ft
	89.2	899	4710+00	9.7		0.7	4071.4	1.7		10.5	0.0	
	89.1	898	4705+00	9.3			4071.3	1.9		9.3	0.0	Edge Velocity
	89.0	897	4700+00	8.9			4071.1	1.6		9.5	0.0	<=4 ft/s and > 3 ft/s
	88.9	896	4695+00	8.1		0.1	4071.0	2.0		9.5	0.0	> 4 ft/s
	88.8	895	4690+00	8.1		0.6	4070.7	1.8		9.3	0.0	
Wetlands Unit A Site	88.7	894.0	4685+00	9.5		0.4	4069.9	2.3		9.9	0.0	Water Surface Elev. Change

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Table C.2 Hydraulic Modeling Results for Cross Sections

	Miles North of American Dam	Cross Section Number	Station Number	West Side, (Right Looking Downstream) Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	East Side, (Left Looking Downstream) Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)	
	88.6	893.0	4680+00	8.9			4069.5	2.8		9.9	0.0	decrease
	88.5	892.0	4675+00	8.9			4069.2	3.0		10.3	0.0	<2 ft and >=0 ft increase
	88.4	891.0	4670+00	8.9			4068.5	2.6		11.3	0.0	>= 2 ft increase
	88.4	890.0		8.3			4068.3			8.9	0.0	
	88.3	889		8.3			4068.2			8.8	0.0	
	88.2	888	4655+00	8.3			4067.7			9.3	0.0	
Salem Bridge (NM 391)		887.5		7.1		1.5	4067.3	2.1		9.9	0.0	
		887.4		7.3		2.0	4067.1	3.1		10.1	0.0	
		887.3		7.4		1.9	4067.0	3.1		10.2	0.0	
		887.2		7.3		1.5	4067.1	2.1		10.1	0.0	
	88.0	887	4645+00	9.2			4066.8			9.8	0.0	
	87.9	886	4640+00	9.7			4066.1			10.1	0.0	
	87.8	885	4635+00	9.3			4065.7	0.0		10.3	0.1	
	87.7	884	4630+00	9.1			4065.5			9.7	0.1	
	87.6	883	4625+00	8.9			4065.3			9.9	0.1	
Wetlands Unit B Site	87.5	882.0	4620+00	9.4			4064.8			9.8	0.1	
	87.4	881.0	4615+00	9.3			4064.6			8.6	0.1	
	87.3	880.0	4610+00	9.2			4064.5			8.6	0.1	
	87.2	879.0	4605+00	9.1		0.3	4064.1			8.5	0.1	
	87.1	878.0	4600+00	9.2		0.5	4063.9			8.1	0.1	
	87.0	877	4595+00	8.4			4063.8	0.4		7.2	0.1	
	86.9	876	4590+00	8.2			4063.6			7.2	0.1	
	86.8	875	4585+00	8.1		0.6	4063.5	0.6		6.8	0.1	**Levee Freeboard**
	86.7	874	4580+00	7.3		0.6	4063.3	0.6		6.7	0.2	<3 ft and > 1 ft
	86.6	873	4575+00	6.9		1.1	4063.1	0.7		6.7	0.2	<=1 ft and > 0 ft
	86.6	872	4570+00	7.3		0.8	4062.8	0.8		7.0	0.2	<= 0 ft
	86.5	871	4565+00	7.0		0.5	4062.7	0.8		6.4	0.2	
	86.5	870.5	4565+00	5.0		0.6	4062.6	1.1		4.4	0.2	**Edge Velocity**
Hatch Bridge (US 85)		870.4		5.1		0.8	4062.5	1.6		4.5	0.2	<=4 ft/s and > 3 ft/s
		870.3		5.1		0.8	4062.5	1.5		4.5	0.2	> 4 ft/s
		870.2		5.1		0.6	4062.5	1.1		4.5	0.2	
Garfield Drain Site	86.3	870.0	4555+00	5.2		0.8	4062.4	0.3		-0.5	0.2	**Water Surface Elev. Change**
	86.2	869.0	4550+00	4.9		0.8	4062.1	0.4		-2.3	0.2	decrease
	86.1	868.0	4545+00	4.3		1.0	4062.0	1.0		1.1	0.2	<2 ft and >=0 ft increase

Table C.2 Hydraulic Modeling Results for Cross Sections

	Miles North of American Dam	Cross Section Number	Station Number	West Side, (Right Looking Downstream) Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	East Side, (Left Looking Downstream) Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)	
	85.9	867.0	4535+00	5.2		1.3	4061.2	0.4		-0.4	0.1	>= 2 ft increase
	85.8	866	4530+00	4.6		1.1	4061.1	1.7		3.3	0.2	
	85.7	865	4525+00	5.3		1.2	4060.6	0.6		4.7	0.3	
	85.5	864	4515+00	5.7		1.8	4060.1	0.5		20.5	0.4	
Placitas Arroyo Site	85.4	863.0	4510+00	5.3		1.2	4059.5	0.2		5.0	0.5	
	85.3	862.0	4505+00	4.8		1.3	4059.3	0.3		1.7	0.5	
	85.2	861.0	4500+00	4.9		1.7	4058.9	0.5		0.3	0.4	
	85.1	860.0	4495+00	5.3		1.7	4058.3	0.4		0.4	0.7	
	85.0	859.0	4490+00	4.8		1.5	4058.2	0.4		0.1	0.6	
	84.9	858.0		4.7		1.7	4058.1	0.4		4.1	0.5	
	84.8	857.0	4480+00	3.8		0.4	4058.0	0.3		-0.4	0.6	
	84.8	856.0	4475+00	5.5		0.5	4056.5	0.4		0.6	0.2	
	84.7	855.0	4470+00	4.9		0.4	4056.4	0.4		0.7	0.1	
	84.6	854.0	4465+00	4.4		0.4	4056.2	0.4		0.9	0.1	
	84.5	853.0	4460+00	5.5		0.5	4055.5	0.4		4.6	-0.2	
	84.4	852.0	4455+00	5.1		0.5	4054.9	0.5		5.9	-0.6	
		851.50		12.7		2.9	4054.6	3.3		14.1	0.0	
		851.40		12.7		3.3	4054.6	3.6		14.1	0.0	
		851.30		12.8		3.3	4054.5	3.7		14.2	0.0	
		851.20		12.8		2.9	4054.5	3.3		14.2	0.2	
	84.1	851.0	4440+00	6.0		1.9	4053.6	2.1		32.2	0.2	Levee Freeboard
	84.0	850.0	4435+00	5.7		1.8	4053.4	1.6		10.5	0.2	<3 ft and > 1 ft
	83.9	849.0	4430+00	4.2		1.7	4053.3	1.6		18.9	0.2	<=1 ft and > 0 ft
	83.8	848.0	4425+00	3.7		1.7	4053.3	1.2		21.5	0.2	<= 0 ft
	83.7	847.0	4420+00	4.0		2.0	4053.0	1.5		19.6	0.3	
	83.6	846.0	4415+00	3.1		2.0	4052.9	1.6		29.1	0.3	Edge Velocity
	83.5	845.0	4410+00	3.5		1.8	4052.5	1.7		16.0	0.4	<=4 ft/s and > 3 ft/s
	83.4	844.0	4405+00	4.5		1.7	4052.3	2.1		24.3	0.5	> 4 ft/s
	83.3	843.0	4400+00	3.7		2.2	4052.1	2.2		21.4	0.6	
Remnant Bosque Site	83.2	842.0	4395+00	4.1		0.5	4051.9	2.7		31.1	0.5	Water Surface Elev. Change
	83.1	841.0	4390+00	3.4		0.4	4051.7	2.3		19.4	0.7	decrease
	83.0	840.0	4385+00	3.3		0.5	4051.5	2.7		14.5	0.7	<2 ft and >=0 ft increase
	83.0	839.0	4380+00	3.5		0.5	4051.3	1.8		11.5	0.7	>= 2 ft increase
	82.9	838.0	4375+00	3.0		0.6	4051.1	2.0		15.4	0.8	

Table C.2 Hydraulic Modeling Results for Cross Sections

				West Side, (Right Looking Downstream)			Water Elev. Main Channel (ft)	East Side, (Left Looking Downstream)			
	Miles North of American Dam	Cross Section Number	Station Number	Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)
	82.8	837.0	4370+00	2.6		0.5	4050.7	0.5		16.0	0.6
	82.7	836.0	4365+00	2.4		0.5	4050.4	0.5		17.2	0.5
	82.6	835.0	4360+00	1.2		0.5	4050.5	0.4		5.8	0.5
	82.5	834.0	4355+00	0.9		0.6	4050.1	0.5		9.4	0.3
	82.4	833.0	4350+00	0.7		0.6	4049.8	0.5		2.5	0.2
	82.3	832.0	4345+00	1.1		0.5	4049.8	0.5		1.6	0.1
	82.2	831.0	4340+00	1.1		0.6	4049.4	0.5		1.7	0.0
	82.1	830.0	4335+00	1.5		0.8	4048.7	0.7		3.8	-0.4
ATSF Railroad Bridge		829.50		6.1		2.4	4047.6	2.7		6.1	0.0
		829.40		6.4		2.6	4047.3	2.9		6.4	0.0
Rincon - Hatch Bridge (NM 140, Sta		829.30		6.4		2.6	4047.3	2.9		6.5	0.0
		829.20		6.4		2.4	4047.3	2.7		6.4	0.0
		829.10		0.8		1.6	4047.4	2.1		1.7	0.0
		829.0		0.8		1.6	4047.4	2.1		1.7	0.0
Rincon Siphon		828.50		3.3		3.3	4047.1	3.0		3.2	0.0
		828.40		3.6		4.7	4046.8	4.0		3.5	0.0
		828.30		3.8		4.8	4046.6	4.1		3.7	0.0
		828.20		3.8		3.5	4046.6	3.2		3.7	0.0
		828.0		4.4		4.2	4046.4	4.0		4.4	0.0
		827.0		5.1		4.5	4045.7	4.3		5.1	0.0
		826.0		4.8		4.6	4045.6	4.5		5.0	0.0
		825.0		5.0		4.2	4044.6	3.4		5.9	0.0
		824.0		6.6		2.9	4043.0			6.7	0.0
		823.0		7.7			4041.9			7.3	0.1
		822.0		7.5		0.4	4042.1	0.3		6.9	0.0
		821.0		7.6		0.5	4042.1	0.4		7.0	0.1
	81.8	820.0	4320+00	7.5		0.1	4042.2	0.2		6.5	0.1
	81.7	819.0	4315+00	7.1			4041.8			6.8	0.0
	81.6	818.0	4310+00	7.1		0.6	4041.5			6.3	0.1
	81.5	817.0	4305+00	6.7		1.0	4041.3			6.5	0.1
	81.4	816.0	4300+00	7.1		1.3	4040.9			6.7	0.1
	81.3	815.0	4295+00	7.0		1.3	4040.6			6.3	0.1
	81.3	814.0	4290+00	6.8		1.1	4040.0	0.4		6.1	0.2
	81.2	813.0	4285+00	6.5		1.2	4039.8			5.0	0.2

Levee Freeboard
- <3 ft and > 1 ft
- <=1 ft and > 0 ft
- <= 0 ft

Edge Velocity
- <=4 ft/s and > 3 ft/s
- > 4 ft/s

Water Surface Elev. Change
- decrease
- <2 ft and >=0 ft increase
- >= 2 ft increase

Table C.2 Hydraulic Modeling Results for Cross Sections

	Miles North of American Dam	Cross Section Number	Station Number	West Side, (Right Looking Downstream) Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	East Side, (Left Looking Downstream) Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)	
	81.1	812.0	4280+00	6.5		1.3	4039.7	0.8		5.3	0.3	
	81.0	811.0	4275+00	6.5		0.9	4039.5	0.7		5.6	0.3	
Angostura Arroyo Site	80.9	810.0	4270+00	6.7		0.2	4039.3	0.2		5.5	0.3	
	80.8	809.0	4265+00	5.4		0.2	4039.2	0.3		4.7	0.3	
	80.7	808.0	4260+00	5.8		0.3	4039.0	0.2		5.0	0.3	
	80.6	807.0	4255+00	5.4		0.2	4038.6	0.2		4.9	0.4	
	80.5	806.0	4250+00	4.4		0.2	4038.6	0.3		4.6	0.4	
	80.4	805.0	4245+00	19.6		0.3	4038.6	0.2		4.8	0.4	
	80.3	804.0	4240+00	19.5		0.3	4038.4	0.3		4.0	0.4	
	80.2	803.0	4235+00	12.9		0.4	4038.1	0.4		4.1	0.3	
	80.0	802.0	4225+00	12.3		0.2	4037.1	0.4		5.1	0.2	
	79.9	801.0	4220+00	10.2		1.6	4037.3	0.4		2.9	0.2	
	79.8	800.0	4215+00	4.9		0.5	4036.3	0.5		4.2	-0.1	
	79.7	799	4210+00	4.9		2.4	4036.2	1.6		5.0	0.3	
	79.6	798	4205+00	5.8		2.5	4035.9	1.1		3.8	0.3	
	79.5	797	4200+00	3.9		2.2	4035.9	2.0		3.5	0.3	
	79.5	796	4195+00	4.6		2.2	4035.8	2.1		3.6	0.4	**Levee Freeboard**
	79.4	795	4190+00	4.5		2.3	4035.7	2.1		3.8	0.4	**<3 ft and > 1 ft**
	79.3	794	4185+00	3.9		2.2	4035.6	2.2		2.6	0.4	**<=1 ft and > 0 ft**
	79.2	793	4180+00	4.1		2.3	4035.4	2.3		2.9	0.5	**<= 0 ft**
	79.1	792	4175+00	4.0		2.5	4035.2	1.7		3.7	0.5	
	79.0	791	4170+00	3.5		2.1	4035.1	1.5		1.9	0.5	**Edge Velocity**
New Rincon Bridge		790.5		4.6		1.8	4034.8	2.3		6.0	0.6	**<=4 ft/s and > 3 ft/s**
		790.4		4.6		2.3	4034.8	2.9		6.0	0.6	**> 4 ft/s**
		790.3		4.6		2.3	4034.8	2.9		6.0	0.6	
		790.2		4.6		1.8	4034.8	2.3		6.0	0.6	**Water Surface Elev. Change**
Rincon/Reed Arroyo Site	78.7	790.0	4155+00	2.0		1.4	4034.6	0.4		2.0	0.6	**decrease**
Rincon Arroyo	78.5	789.0	4145+00	3.8		0.8	4031.2	0.6		5.4	0.0	**<2 ft and >=0 ft increase**
	78.4	788.0	4140+00	3.4		0.5	4031.6	0.5		3.1	0.4	**>= 2 ft increase**
	78.3	787.0	4135+00	5.5		0.4	4031.1	0.5		2.3	0.8	
	78.2	786.0	4130+00	3.9		0.5	4031.1	0.3		2.3	0.8	
	78.1	785.0	4125+00	2.8		0.6	4030.6	0.4		2.8	0.8	
		784.0		2.9		0.5	4030.5	0.5		2.9	0.8	
	77.8	783.0	4110+00	4.1		0.8	4028.9	0.8		3.3	-0.2	

J:\736620\Alternatives Evaluation_4.7 Perform hydrologic Modeling (Version 7)\TableC2.xls\Whole River

Table C.2 Hydraulic Modeling Results for Cross Sections

				West Side, (Right Looking Downstream)				East Side, (Left Looking Downstream)				
	Miles North of American Dam	Cross Section Number	Station Number	Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)	
	77.7	782.0	4105+00	4.7		0.7	4028.3	0.7		3.7	-0.3	
	77.7	781.0	4100+00	5.0		0.6	4028.0	0.6		4.8	-0.2	
	77.6	780.0	4095+00	5.3		1.6	4027.7	2.8		4.7	0.0	
	77.5	779	4090+00	4.8		1.4	4026.9	3.1		4.9	0.1	
	77.4	778	4085 +00	4.1		1.3	4026.9	2.9		3.9	0.1	
	77.3	777	4080+00	4.4		2.0	4026.6	3.1		4.3	0.1	
	77.2	776	4075+00	4.7		2.4	4026.4	2.6		3.3	0.1	
	77.1	775	4070+00	4.7		2.3	4026.0	2.3		3.7	0.1	
	77.0	774		4.4		2.8	4025.4	2.5		4.0	0.3	
	76.9	773	4060+00	3.9		1.9	4025.2	2.7		3.9	0.3	
	76.8	772	4055+00	3.5		2.3	4025.1	2.4		3.7	0.3	
Bignell Arroyo Site	76.7	771.0	4050+00	2.9		1.6	4025.0	2.5		2.7	0.3	
Wasteway 103	76.6	770.0	4045+00	2.4		1.5	4024.6	2.7		3.4	0.3	
	76.5	769	4040+00	2.5		2.6	4024.4	2.8		3.5	0.4	
	76.4	768	4035+00	2.8		2.0	4024.2	2.7		3.0	0.5	**Levee Freeboard**
	76.3	767	4030+00	1.6		2.6	4024.1	1.8		2.6	0.5	**<3 ft and > 1 ft**
	76.2	766	4025+00	2.8		1.5	4024.1	2.2		1.7	0.5	**<=1 ft and > 0 ft**
	76.1	765.0	4020+00	3.3		0.4	4023.5	0.7		2.1	0.1	**<= 0 ft**
	76.0	764.0	4015+00	2.6		0.5	4023.4	0.5		1.6	0.2	
	75.9	763.0	4010+00	2.8		0.5	4023.3	0.4		2.0	0.2	**Edge Velocity**
	75.9	762.0	4005+00	1.9		0.7	4021.5	0.7		3.5	-0.3	**<=4 ft/s and > 3 ft/s**
	75.8	761	4000+00	11.2		0.6	4021.7	2.5		3.3	0.0	**> 4 ft/s**
	75.7	760.0	3995+00	2.5		0.5	4020.6	3.1		4.5	0.2	
	75.3	759.0	3975+00	0.2		1.1	4020.9	1.3		1.6	-0.1	**Water Surface Elev. Change**
	75.2	758.0	3970+00	15.8		1.0	4020.9	1.2		1.1	-0.1	**decrease**
	75.1	757	3965+00	34.5		1.2	4020.9	1.6		0.5	-0.1	**<2 ft and >=0 ft increase**
	75.0	756	3960+00	17.0		1.3	4020.8	1.8		0.8	-0.1	**>= 2 ft increase**
	74.9	755	3955+00	9.0		0.6	4020.6	1.7		1.0	-0.1	
	74.8	754	3950+00	-0.9		0.6	4020.7	1.2		0.5	-0.1	
	74.7	753	3945+00	17.3		0.8	4020.6	1.2		-0.6	-0.1	
	74.6	752	3940+00	11.6		1.1	4020.6	1.5		-0.3	-0.1	
	74.5	751	3935+00	12.3		0.8	4020.5	1.3		-0.3	-0.1	
	74.4	750.0	3930+00	10.5		0.4	4020.3	2.1		-0.5	0.0	
	74.3	749	3925+00	5.4		0.3	4020.2	2.0		-2.2	0.0	

Table C.2 Hydraulic Modeling Results for Cross Sections

	Miles North of American Dam	Cross Section Number	Station Number	West Side, (Right Looking Downstream) Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	East Side, (Left Looking Downstream) Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)
	74.2	748	3920+00	6.4		1.4	4019.6	1.9		-0.6	0.1
	74.1	747	3915+00	5.1		1.3	4019.4	1.6		-0.8	0.1
	74.1	746	3910+00	6.2		1.7	4019.4	1.7		-2.2	0.1
	74.0	745	3905+00	7.1		1.2	4019.4	1.6		-2.4	0.1
	73.9	744	3900+00	6.8		1.3	4019.4	1.8		-3.4	0.2
Tonuco Bridge		743.3		-0.9		2.8	4016.7	1.6		-0.5	0.0
		743.2		2.7		0.9	4013.1	2.1		3.1	0.0
	73.8	743	3895+00	8.0		1.4	4012.6	3.1		3.6	0.0
	73.7	742	3890+00	17.8		2.3	4012.8	2.1		2.8	0.0
	73.6	741	3885+00	19.0		2.6	4012.6	1.9		2.4	0.0
	73.5	740.0	3880+00	19.3		2.7	4012.2	2.4		2.6	0.0
	73.4	739	3875+00	15.1		2.9	4011.7	2.6		2.3	0.0
	73.3	738	3870+00	15.1		2.7	4011.6	2.5		2.3	0.0
	73.2	737	3865+00	15.4		2.3	4010.9	2.7		3.0	0.0
	73.1	736	3861+17.8	9.4		2.4	4010.9	2.2		2.9	0.0
	73.0	735	3855+00	5.8		2.9	4010.7	2.3		2.3	0.0
	72.9	734	3850+00	6.2		2.6	4010.4	2.4		1.8	0.0
	72.8	733	3845+00	4.3		3.0	4010.3	2.3		2.3	0.0
	72.7	732	3840+00	9.7		2.9	4010.0	2.3		2.1	0.0
	72.6	731	3835+00	12.3		2.5	4009.5	2.7		1.5	0.0
	72.6	730.0	3835+00	11.3		0.4	4009.5	2.2		1.1	0.0
	72.4	729	3825+00	10.6		0.3	4009.3	2.1		0.7	0.0
	72.3	728	3820+00	10.8		0.4	4009.2	3.1		1.2	0.0
	72.3	727	3815+00	11.2			4009.0	3.1		0.8	0.0
	72.2	726	3810+00	11.6			4008.8	3.3		0.8	0.0
	72.1	725	3805+00	13.9			4008.1	3.4		1.6	0.0
	72.0	724	3800+00	21.4			4005.4	4.7		3.6	0.0
Lower Rincon Management Unit	71.9	723	3795+00	14.7			4006.0	0.7		-4.2	-1.1
Seldon Canyon Management Unit	71.8	722	3790+00	8.0			4006.0	0.7		-3.4	-1.1
	71.7	721	3785+00	5.1			4006.0	0.7		-3.2	-1.1
	71.6	720.0	3780+00	15.7		0.5	4005.9	0.8		-0.8	-1.1
	71.5	719	3775+00	6.9		0.4	4005.9	0.8		-3.3	-1.1
	71.4	718	3770+00	15.2			4005.9	0.9		-6.2	2.6
	71.3	717	3765+00	22.9			4005.8	0.9		-6.2	2.5

Levee Freeboard
- <3 ft and > 1 ft
- <=1 ft and > 0 ft
- <= 0 ft

Edge Velocity
- <=4 ft/s and > 3 ft/s
- > 4 ft/s

Water Surface Elev. Change
- decrease
- <2 ft and >=0 ft increase
- >= 2 ft increase

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Table C.2 Hydraulic Modeling Results for Cross Sections

				West Side, (Right Looking Downstream)				East Side, (Left Looking Downstream)				
	Miles North of American Dam	Cross Section Number	Station Number	Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)	
	71.2	716	3760+00	18.8		0.3	4005.8	0.9		-7.0	2.6	
	71.1	715	3755+00	16.1			4002.2	0.4		1.8	-0.8	
	71.0	714	3750+00	-0.3		0.6	4002.7	1.3		-2.5	-0.3	
	70.9	713	3745+00	-0.5		0.7	4002.5	1.3		-2.6	-0.3	
	70.8	712	3740+00	-0.3		0.7	4002.3	1.3		-2.3	-0.3	
	70.7	711	3735+00	-1.1		0.9	4002.2	0.9		-2.8	0.1	
	70.6	710.0	3730+00	-1.0		1.1	4001.8	1.1		-1.9	0.5	
	70.5	709	3725+00	16.3		1.3	4000.9	1.7		43.0	0.1	
	70.5	708	3720+00	-1.0		1.0	4000.8	1.3		14.6	0.3	
	70.4	707	3715+00	5.7		0.8	4000.6	1.0		15.1	0.2	
	70.3	706	3710+00	2.2		0.9	4000.6	0.9		11.2	0.2	**Levee Freeboard**
	70.2	705	3705+00	0.4		1.5	4000.3	1.3		9.6	0.3	**<3 ft and > 1 ft**
Seldon Canyon	70.1	704	3700+00	-1.6		1.4	4000.2	1.5		11.7	0.4	**<=1 ft and > 0 ft**
	70.0	703	3695+00	-2.2		1.4	4000.0	1.4		10.7	0.5	**<= 0 ft**
	69.9	702	3690+00	-2.3		1.4	3999.9	1.4		11.0	0.5	
	69.8	701	3685+00	-1.9		1.3	3999.7	1.3		10.2	0.5	**Edge Velocity**
	69.7	700.0	3680+00	-1.9		0.7	3999.7	1.3		4.8	0.5	**<=4 ft/s and > 3 ft/s**
	69.6	699	3675+00	-1.7		0.6	3999.7	1.2		9.2	0.6	**> 4 ft/s**
	69.5	698	3670+00	-1.4		0.5	3999.6	1.1		12.3	0.6	
	69.4	697	3665+00	11.4		0.4	3999.4	1.4		9.5	0.6	**Water Surface Elev. Change**
Dead Man's Curve Site	69.3	696.0	3660+00	11.6		1.7	3998.4	0.8		2.6	-0.1	**decrease**
	69.2	695.0	3655+00	9.7		1.1	3998.7	0.4		4.7	0.2	**<2 ft and >=0 ft increase**
	69.1	694.0	3650+00	10.2		1.0	3998.6	0.4		10.2	0.2	**>= 2 ft increase**
	69.0	693.0	3645+00	10.4		0.9	3998.4	0.4		9.5	0.2	
	68.9	692.0	3640+00	5.1		1.5	3998.3	0.3		10.5	0.1	
	68.8	691.0	3635+00	7.5		1.3	3998.4	0.3		8.5	0.1	
	68.8	690.0	3630+00	8.5		1.1	3998.3	0.3		8.5	0.1	
	68.7	689.0	3628+20.4	3.4		1.1	3998.3	0.3		8.5	0.1	
	68.6	688.0	3622+50	1.7		1.0	3998.2	0.3		8.6	0.1	
		687.0		8.6		0.9	3998.2	0.3		8.6	0.1	
	68.4	686	3614+09.4	7.0		0.8	3998.0	0.8		7.0	0.1	
	68.4	685	3610+00	6.8		1.1	3997.4	0.9		7.6	0.2	
	68.2	684	3603+50.3	4.8		1.0	3997.1	1.3		7.0	0.2	
	68.2	683	3599+61.6	2.6		0.7	3997.4	0.7		14.6	0.2	

Table C.2 Hydraulic Modeling Results for Cross Sections

				West Side, (Right Looking Downstream)				East Side, (Left Looking Downstream)				
	Miles North of American Dam	Cross Section Number	Station Number	Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)	
Broad Canyon Site	68.1	682.0	3595+88.5	25.6		1.3	**3997.3**	0.3		1.7	**0.3**	
	67.9	681.0	3585+00	4.4		0.6	**3995.6**	0.8		3.2	**-0.3**	
	67.8	680.0	3580+00	12.1		1.1	**3995.6**	1.2		15.8	**0.0**	
	67.6	679.0	3570+00	13.3		2.2	**3994.3**	0.9		7.0	**0.0**	
	67.5	678.0	3565+00	11.8		3.3	**3992.6**	1.2		25.0	**0.0**	
	67.4	677.0	3560+00	7.5		2.0	**3992.1**	1.6		20.4	**0.0**	
Buckle Canyon	67.3	676.0	3555+00	8.6		1.8	**3991.2**	1.5		4.2	**0.0**	
	67.2	675.0	3550+00	10.1		1.7	**3991.2**	1.5		13.6	**0.3**	
	67.1	674.0	3545+00	20.7		2.2	**3991.1**	0.8		22.0	**0.1**	**Levee Freeboard**
	67.0	673.0	3540+00	9.8		2.7	**3990.8**	0.8		15.5	**0.1**	**<3 ft and > 1 ft**
	67.0	672.0	3535+00	18.9		2.5	**3990.8**	0.7		20.0	**0.2**	**<=1 ft and > 0 ft**
	66.9	671.0	3530+00	8.6		2.2	**3990.6**	0.6		18.8	**0.2**	**<= 0 ft**
	66.8	670.0	3525+00	10.1		1.9	**3990.2**	0.7		20.1	**0.2**	
	66.7	669.0	3520+00	2.5		1.0	**3990.3**	1.0		17.7	**0.2**	**Edge Velocity**
	66.6	668.0	3515+00	23.0		2.2	**3988.1**	1.7		27.8	**-0.9**	**<=4 ft/s and > 3 ft/s**
	66.1	667.0	3492+57.5	14.9		1.2	**3987.5**	1.1		19.3	**-0.9**	**> 4 ft/s**
	66.1	666.0	3490+00	12.5		1.2	**3987.4**	0.2		44.6	**-0.9**	
	66.1	665.0	3487+50	8.3		1.3	**3987.1**	0.5		35.1	**-1.0**	**Water Surface Elev. Change**
	66.0	664.0	3485+00	2.8		1.6	**3986.5**	1.0		8.6	**-1.3**	**decrease**
	65.8	663.0	3475+00	26.2		0.8	**3986.3**	2.6		9.5	**-1.5**	**<2 ft and >=0 ft increase**
	65.7	662.0	3470+00	19.6		0.5	**3986.1**	2.6		4.5	**-1.6**	**>= 2 ft increase**
	65.6	661.0	3465+00	33.6		1.1	**3985.7**	2.1		3.6	**-1.7**	
	65.5	660.0	3460+00	4.2		1.0	**3985.5**	2.1		6.8	**-1.8**	
	65.4	659.0	3455+00	10.0		1.7	**3984.9**	1.2		9.9	**-1.6**	
	65.3	658.0	3450+00	16.6		1.4	**3985.0**	0.5		14.4	**-1.6**	
	65.2	657.0	3445+00	6.9		1.8	**3984.2**	0.6		24.3	**-1.6**	
	65.2	656.0	3440+00	6.7		1.5	**3984.1**	0.6		13.9	**-1.7**	
	65.1	655.0	3435+00	27.9		1.5	**3983.9**			44.5	**-1.8**	
	65.0	654.0	3430+00	17.0		1.2	**3983.8**	0.4		10.0	**-1.8**	
	64.9	653.0	3425+00	7.2		1.8	**3983.3**	1.4		6.9	**-0.2**	
	64.8	652.0	3420+00	-2.3		1.2	**3983.4**	0.4		65.1	**-0.8**	
	64.7	651.0	3415+00	17.3		1.4	**3983.1**	0.4		14.6	**-0.4**	
	64.6	650.0	3410+00	16.4		1.6	**3982.4**	0.5		19.4	**0.3**	
	64.5	649.0	3405+00	25.3		1.3	**3982.3**	0.6		39.8	**-0.1**	

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Table C.2 Hydraulic Modeling Results for Cross Sections

				West Side, (Right Looking Downstream)				East Side, (Left Looking Downstream)				
	Miles North of American Dam	Cross Section Number	Station Number	Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)	
	64.4	648.0	3400+00	8.1		1.2	3982.1	1.4		5.4	-0.1	
	64.3	647.0	3395+00	60.9		1.1	3981.9	1.1		48.0	-0.2	
	64.2	646.0	3390+00	19.4		0.8	3981.9	0.9		46.8	-0.2	
Foster Canyon	64.1	645.0	3383+86	5.7		0.7	3979.8	2.0		27.9	0.3	
	64.0	644.0	3380+00	20.9		1.5	3980.0	1.7		25.3	0.3	
	64.0	643.0	3377+50	25.0		1.3	3979.9	1.7		4.5	0.3	
	63.7	642.0	3365+00	29.8		1.1	3979.6	1.8		40.8	0.8	**Levee Freeboard**
	63.6	641.0	3360+00	18.9		0.9	3979.6	1.3		8.9	0.7	<3 ft and > 1 ft
	63.5	640.0	3355+00	8.2		1.0	3979.5	1.3		11.2	0.7	<=1 ft and > 0 ft
	63.4	639.0	3345+00	9.4		1.3	3979.3	1.5		40.1	1.1	<= 0 ft
Faulkner Canyon	63.3	638.0	3340+00	11.1			3976.0	3.9		43.8	-0.4	
	63.0	637.0	3325+00	18.7		2.3	3974.2	1.0		15.4	-0.3	**Edge Velocity**
	62.9	636.0	3320+00	24.9		2.2	3973.6	1.0		8.6	0.2	<=4 ft/s and > 3 ft/s
	62.7	635.0	3310+00	35.3		1.8	3972.9	2.3		7.4	0.0	> 4 ft/s
	62.6	634.0	3305+00	31.0		2.3	3972.5	2.8		10.4	0.0	
	62.5	633.0	3300+00	12.6		2.3	3972.2	2.4		35.5	0.0	**Water Surface Elev. Change**
	62.4	632.0	3295+00	3.5		1.3	3971.5	0.9		15.2	0.0	decrease
Seldon Canyon Management Unit	62.3	631.0	3290+00	2.2		1.2	3971.0	1.7		2.8	0.0	<2 ft and >=0 ft increase
Upper Mesilla Management Unit	62.2	630.0	3285+00	4.2		1.2	3969.9	2.4		9.6	0.0	>= 2 ft increase
	62.1	629.0	3280+00	5.8		1.3	3969.4	1.4		10.4	0.0	
Leasburg Dam Site		628.0		5.7		0.8	3969.7	0.9		1.8	0.0	
		627.0		9.5		0.2	3966.4	0.1		8.4	0.0	
	61.9	626.0	3270+00	0.9		1.4	3965.5	1.3		47.8	0.0	
	61.8	625.0	3265+00	1.2		1.4	3965.0	0.7		41.9	0.0	
	61.7	624.0	3257+50	5.2		1.0	3965.0	2.4		40.7	0.0	
	61.6	623.0	3255 +00	2.3		0.9	3964.9	2.2		30.2	0.0	
	61.6	622.0	3250 +00	4.2		0.8	3964.8	2.4		5.4	0.0	
	61.5	621.0	3245 +00	3.2		1.3	3964.6	0.5		6.6	0.0	
	61.1	620.5	3225+00	3.1		1.7	3964.3	0.4		3.0	0.0	
Leasburg Bridge		620.4		3.2		2.4	3964.2	0.7		3.1	0.0	
		620.3		3.2		1.0	3964.2	0.8		3.1	0.0	
		620.2		3.2		0.7	3964.2	0.4		3.1	0.0	
		620.0		0.2		0.6	3964.3	0.3		0.7	0.0	
	61.0	619.0	3220+00	0.3		0.6	3964.2	0.4		0.6	0.0	

Table C.2 Hydraulic Modeling Results for Cross Sections

	Miles North of American Dam	Cross Section Number	Station Number	West Side, (Right Looking Downstream) Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	East Side, (Left Looking Downstream) Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)	
	60.8	618.0	3210+00	10.9		2.3	3962.1	1.3		2.7	0.0	
	60.7	617.0	3205+00	14.2		2.3	3959.9	0.4		5.0	0.0	
	60.6	616.0	3200+00	12.0		3.5	3958.1			6.5	0.0	
	60.5	615.0	3195+00	8.9		2.1	3959.1			6.3	0.0	
	60.4	614.0	3190+00	9.4		2.1	3958.6	0.6		6.4	0.0	**Levee Freeboard**
	60.2	613.0	3180+00	11.6		2.6	3958.3			6.7	0.0	**<3 ft and > 1 ft**
	60.1	612.0	3175+00	10.2		3.3	3957.6	0.5		7.4	0.0	**<=1 ft and > 0 ft**
	60.0	611.0	3170+00	11.1		3.8	3956.7	0.5		7.5	0.0	**<= 0 ft**
	59.9	610.0	3165+00	10.9		2.2	3957.0	0.5		6.0	0.0	
	59.8	609.0	3160+00	11.2		2.4	3956.8	0.6		3.2	0.0	**Edge Velocity**
	59.8	608.0	3155+00	10.8		1.8	3956.0	2.3		6.6	0.0	**<=4 ft/s and > 3 ft/s**
	59.7	607.0	3150+00	5.2		2.2	3955.6	2.1		6.1	0.0	**> 4 ft/s**
	59.6	606.0	3145+00	6.4		2.2	3955.3	2.0		5.7	0.0	
	59.5	605.0	3140+00	10.8		1.8	3955.2	1.7		5.6	0.0	**Water Surface Elev. Change**
	59.4	604.0	3135+00	10.9		2.0	3955.1	1.3		6.1	0.0	**decrease**
	59.3	603.0	3130+00	9.9		2.2	3954.7	1.9		7.1	0.0	**<2 ft and >=0 ft increase**
	59.2	602.0	3125+00	10.6		2.8	3954.4	2.0		6.7	0.0	**>= 2 ft increase**
	59.1	601.0	3122+50	10.6		2.5	3954.2	2.0		5.4	0.0	
	58.9	600.0	3110+00	11.2		2.3	3953.6	2.3		2.2	0.0	
	58.8	599.0	3105+00	12.2		1.6	3952.6	2.3		2.5	0.0	
	58.7	598.0	3100+00	12.1		1.5	3952.7	2.6		1.5	0.0	
	58.6	597.0	3095+00	10.0		1.4	3951.8	2.8		2.8	0.0	
	58.5	596.0	3090+00	10.0		1.6	3951.8	2.4		2.4	0.0	
	58.4	595.0	3085+00	10.2		1.9	3951.6	2.4		2.3	0.0	
	58.3	594.0	3080+00	10.9		1.9	3951.1	2.3		2.1	0.0	
	58.2	593.0	3075+00	12.7		1.9	3950.0	3.5		3.0	0.0	
	58.1	592.0	3070+00	15.3		1.6	3947.7	2.2		4.5	0.0	
	58.0	591.0	3065+00	13.9		2.8	3948.1	1.5		3.5	0.7	
West Side Site	58.0	590.0	3060+00	7.5		0.8	3947.5	0.5		4.3	0.3	
	57.9	589.0	3055+00	4.0		0.9	3946.8	0.5		4.4	-0.1	
	57.8	588	3050+00	10.9		2.5	3946.9	2.1		3.9	0.3	
	57.7	587	3045+00	10.8		2.2	3946.9	2.2		3.2	0.4	
	57.6	586	3040+00	11.5		1.7	3946.5	2.3		2.7	0.4	
	57.5	585	3035+00	11.8			3946.2	2.3		3.8	0.5	

Table C.2 Hydraulic Modeling Results for Cross Sections

	Miles North of American Dam	Cross Section Number	Station Number	West Side, (Right Looking Downstream) Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	East Side, (Left Looking Downstream) Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)	
Levee Setback Site	57.4	584.0	3030+00	2.7		0.4	3945.8	0.6		3.8	0.4	
	57.3	583.0	3025+00	1.9		0.6	3945.7	0.5		3.1	0.4	
	57.2	582.0	3020+00	1.3		0.8	3944.9	0.6		3.9	0.2	**Levee Freeboard**
	57.1	581.0	3015+00	14.6		0.9	3943.4	0.6		5.2	0.3	**<3 ft and > 1 ft**
	56.9	580.0	3005+00	13.7		0.5	3942.4	0.6		5.1	0.0	**<=1 ft and > 0 ft**
	56.8	579.0	3000+00	14.2		0.3	3941.8	0.6		5.2	0.2	**<= 0 ft**
	56.7	578.0	2995+00	14.5		0.6	3941.6	0.5		5.1	0.1	
	56.6	577.0	2990+00	13.6		0.5	3941.0	0.6		5.2	-0.1	**Edge Velocity**
	56.5	576.0	2985+00	14.0		0.4	3940.6	0.4		5.0	-0.1	**<=4 ft/s and > 3 ft/s**
	56.4	575	2980+00	14.0		0.9	3940.6	1.7		5.0	0.1	**> 4 ft/s**
	56.3	574	2975+00	14.5		1.4	3940.1	2.5		5.1	0.1	
	56.3	573	2970+00	12.9		1.2	3939.9	2.0		5.1	0.1	**Water Surface Elev. Change**
	56.2	572	2965+00	13.1		1.3	3939.7	2.0		4.5	0.1	**decrease**
	56.1	571	2960+00	13.6		1.8	3939.2	2.4		5.1	0.2	**<2 ft and >=0 ft increase**
Seldon Drain Site	56.0	570.0	2955+00	13.0		0.5	3938.8	1.5		5.0	0.0	**>= 2 ft increase**
Wasteway 2	55.9	569.0	2950+00	13.2		0.3	3938.6	1.3		5.0	0.1	
	55.7	568.0	2942+50	8.6		0.6	3938.1	1.2		4.6	-0.1	
	55.7	567.0	2940+00	5.1		0.5	3937.7	1.0		4.8	-0.1	
Wasteway 24	55.6	566	2935+00	13.8		1.1	3937.5	2.4		4.5	0.0	
	55.5	565	2930+00	12.5		0.5	3937.5	2.0		4.3	0.0	
	55.4	564	2925+00	11.7		0.8	3937.1	2.6		4.7	0.0	
	55.3	563	2920+00	12.1		2.8	3936.7	2.7		4.5	0.0	
	55.2	562	2915+00	11.6		2.7	3936.4	2.7		3.8	0.0	
	55.1	561	2910+00	12.9		2.8	3935.1	3.0		5.1	0.4	
	55.0	560.0	2905+00	13.2		3.6	3934.8	3.1		4.4	0.6	
	54.9	559	2900+00	10.1		3.4	3934.7	2.9		4.1	0.7	
Channel Cut Site	54.8	558.0	2895+00	3.5		0.6	3934.1	0.6		4.4	0.3	
	54.7	557.0	2890+00	1.1		0.5	3933.8	0.6		4.0	0.3	
	54.6	556.0	2885+00	0.8		0.5	3933.4	0.5		3.9	0.0	
	54.5	555.0	2880+00	-1.7		2.1	3933.7	0.4		3.3	0.5	
	54.5	554.0	2875+00	9.6		2.1	3933.6	0.3		3.7	0.5	
	54.4	553.0	2870+00	-0.5		1.9	3933.5	0.2		3.7	0.7	
	54.2	552.0	2862+50	-4.0		1.9	3933.4	0.2		2.0	0.6	
	54.2	551.0	2860+00	-3.9		2.1	3933.4	0.2		1.6	0.6	

Table C.2 Hydraulic Modeling Results for Cross Sections

				West Side, (Right Looking Downstream)				East Side, (Left Looking Downstream)				
	Miles North of American Dam	Cross Section Number	Station Number	Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)	
	54.1	550.0	2855+00	-4.2		2.2	**3933.1**	0.3		2.1	**0.6**	**Levee Freeboard**
	54.0	549.0	2850+00	1.0		0.9	**3931.7**	0.6		3.6	**-0.6**	**<3 ft and > 1 ft**
	53.9	548.0	2845+00	0.5		0.7	**3931.2**	0.7		3.6	**-0.7**	**<=1 ft and > 0 ft**
	53.8	547	2840+00	11.5		2.8	**3930.7**	3.3		3.5	**0.1**	**<= 0 ft**
	53.7	546	2835+00	11.6		2.8	**3930.6**	2.2		3.0	**0.0**	
	53.6	545	2830+00	11.7		3.4	**3929.5**	1.6		4.1	**0.2**	**Edge Velocity**
	53.5	544	2825+00	12.0		2.0	**3929.2**	1.1		3.6	**0.2**	**<=4 ft/s and > 3 ft/s**
	53.4	543	2820+00	8.6		0.9	**3929.2**	1.4		3.4	**0.2**	**> 4 ft/s**
	53.3	542	2815+00	7.1		0.6	**3928.9**	2.0		3.3	**0.3**	
	53.2	541	2810+00	9.8		0.6	**3928.6**	2.5		3.0	**0.3**	**Water Surface Elev. Change**
	53.1	540.0	2805+00	9.9		0.6	**3928.5**	2.3		3.1	**0.4**	**decrease**
Wasteway No. 2A Site	53.0	539.0	2800+00	3.5		0.2	**3928.4**	1.1		2.4	**0.3**	**<2 ft and >=0 ft increase**
	52.9	538.0	2795+00	1.0		0.3	**3928.2**	1.3		1.8	**0.3**	**>= 2 ft increase**
	52.8	537.0	2790+00	-2.2		0.5	**3927.8**	1.3		2.2	**0.3**	
	52.7	536.0	2785+00	-2.0		0.5	**3927.6**	0.4		1.6	**0.2**	
	52.7	535.0	2780+00	-2.4		0.5	**3927.4**	0.4		1.4	**0.1**	
	52.6	534.0	2775+00	-1.0		0.7	**3926.6**	0.4		2.4	**-0.1**	
	52.5	533.0	2770+00	-1.1		0.8	**3926.1**	0.3		2.9	**0.0**	
	52.4	532.0	2765+00	-1.0		0.3	**3925.9**	0.4		2.9	**0.0**	
	52.3	531.0	2760+00	-1.8		0.3	**3925.8**	0.4		2.3	**-0.1**	
	52.1	530.0	2750+00	19.8		1.6	**3925.6**	1.7		1.8	**0.0**	
	52.0	529	2745+00	19.5			**3925.5**	2.2		1.1	**0.0**	
	51.9	528	2740+00	18.0		0.8	**3925.1**	2.5		0.8	**0.0**	
	51.8	527	2735+00	13.6		2.3	**3924.5**	2.4		1.3	**0.0**	
	51.7	526	2730+00	14.9		1.4	**3924.3**	1.8		1.3	**0.0**	
	51.6	525	2725+00	10.8		3.5	**3921.8**	2.8		3.5	**0.0**	
Picacho Flume	51.4	524	2715+00	5.3		1.1	**3920.4**	1.4		7.4	**0.1**	
Shalem Bridge		523.5		4.4		1.5	**3919.9**	2.5		4.3	**0.1**	
		523.4		4.7		2.0	**3919.6**	3.2		4.6	**0.1**	
		523.3		4.8		2.0	**3919.5**	3.2		4.7	**0.1**	
		523.2		4.8		1.5	**3919.5**	2.5		4.7	**0.1**	
	51.1	523	2700+00	5.6		1.3	**3918.8**	1.9		4.8	**0.2**	
	51.0	522	2695+00	5.3		0.6	**3918.7**	1.9		4.4	**0.2**	**Levee Freeboard**
	50.9	521	2690+00	5.3		1.7	**3917.9**	1.4		4.7	**0.4**	**<3 ft and > 1 ft**

Table C.2 Hydraulic Modeling Results for Cross Sections

				West Side, (Right Looking Downstream)				East Side, (Left Looking Downstream)				
	Miles North of American Dam	Cross Section Number	Station Number	Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)	
	50.9	520.0	2685+00	4.9		1.1	**3917.9**	1.5		4.4	**0.4**	**<=1 ft and > 0 ft**
	50.8	519	2680+00	3.6		2.2	**3917.8**	2.5		3.1	**0.5**	**<= 0 ft**
	50.7	518.0	2675+00	3.9		0.4	**3917.6**	2.1		3.6	**0.4**	
	50.6	517.0	2670+00	3.7		0.5	**3917.4**	2.3		3.0	**0.3**	**Edge Velocity**
	50.5	516.0	2665+00	5.3		0.5	**3917.1**	2.1		3.1	**0.2**	**<=4 ft/s and > 3 ft/s**
	50.4	515	2660+00	5.2		2.1	**3917.0**	2.3		3.2	**0.4**	**> 4 ft/s**
	50.3	514	2655+00	5.2		2.4	**3916.6**	2.6		3.6	**0.6**	
Wasteway No. 5 Site (Wasteway 3	50.2	513.0	2650+00	5.7		0.5	**3915.5**	0.6		4.3	**0.2**	**Water Surface Elev. Change**
Wasteway 4 (Dona Ana Dams Outle	50.1	512.0	2645+00	5.1		0.5	**3915.1**	1.8		4.7	**0.2**	**decrease**
	50.0	511.0	2640+00	3.3		0.6	**3915.1**	1.6		2.9	**0.1**	**<2 ft and >=0 ft increase**
	49.9	510.0	2635+00	3.9		0.6	**3914.4**	0.6		4.1	**-0.2**	**>= 2 ft increase**
	49.8	509	2630+00	4.2		2.7	**3914.4**	2.4		3.4	**0.1**	
	49.7	508	2625+00	4.6		2.7	**3914.1**	2.6		3.3	**0.0**	
	49.6	507	2620+00	3.7		2.5	**3913.7**	2.8		3.5	**0.1**	
Upper Mesilla Management Unit	49.5	506	2615+00	2.5		2.8	**3913.3**	3.2		3.1	**0.1**	
Las Cruces Management Unit	49.4	505	2610+00	3.5		2.3	**3913.2**	2.7		2.8	**0.1**	
	49.3	504	2605+00	4.5		2.1	**3912.6**	3.2		2.9	**0.2**	
	49.2	503	2600+00	4.6		2.8	**3911.9**	3.6		3.8	**0.4**	
	49.1	502	2595+00	4.2		2.5	**3911.7**	3.0		2.6	**0.5**	
	49.1	501	2590+00	4.0		2.4	**3911.5**	3.0		3.5	**0.6**	
	49.0	500.0	2585+00	4.6		2.4	**3911.1**	3.0		4.2	**1.1**	
Wasteway No. 39 Site	48.9	499.0	2580+00	5.0		0.6	**3910.0**	0.7		4.6	**0.4**	
	48.8	498.0	2575+00	4.7		1.8	**3909.7**	0.7		3.9	**0.6**	
	48.7	497.0	2570+00	4.8		2.1	**3909.3**	0.6		3.7	**0.7**	
	48.6	496.0	2565+00	6.1		0.8	**3907.9**	0.6		4.7	**-0.3**	
	48.5	495	2560+00	4.8		2.7	**3908.0**	2.5		3.6	**0.4**	
	48.4	494.0	2555+00	4.3		1.5	**3907.8**	2.4		3.6	**0.4**	
	48.3	493.0	2550+00	4.6		1.8	**3907.6**	2.4		3.5	**0.3**	
	48.2	492	2545+00	3.8		2.6	**3907.5**	2.3		4.0	**0.5**	
	48.1	491	2540+00	3.4		2.3	**3907.4**	2.3		2.9	**0.5**	
	48.0	490.0	2535+00	3.8		2.4	**3907.0**	2.9		3.0	**0.7**	**Levee Freeboard**
	47.9	489	2530+00	3.7		2.7	**3906.8**	2.8		3.1	**0.8**	**<3 ft and > 1 ft**
	47.8	488	2525+00	3.4		2.5	**3906.7**	2.8		2.4	**1.0**	**<=1 ft and > 0 ft**
Wasteway No. 8 Site	47.7	487.0	2520+00	2.8		2.3	**3906.3**	2.0		2.3	**0.8**	**<= 0 ft**

J:\736620\Alternatives Evaluation_4.7 Perform hydrologic Modeling (Version 7)\TableC2.xls\Whole River

Table C.2 Hydraulic Modeling Results for Cross Sections

	Miles North of American Dam	Cross Section Number	Station Number	West Side, (Right Looking Downstream) Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	East Side, (Left Looking Downstream) Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)	
	47.6	486.0	2515+00	2.3		2.5	3906.1	1.9		2.5	0.9	
	47.5	485.0	2510+00	3.4		2.9	3905.2	0.8		3.0	0.3	**Edge Velocity**
	47.4	484.0	2505+00	2.3		3.1	3904.9	0.7		2.4	0.4	**<=4 ft/s and > 3 ft/s**
	47.3	483	2500+00	1.6		2.5	3905.0	2.6		1.5	0.7	**> 4 ft/s**
Wasteway No. 39A Site	47.3	482.0	2495+00	2.1		3.1	3904.3	0.7		2.0	0.3	
	47.2	481.0	2490+00	2.3		3.3	3904.1	0.7		2.1	0.3	**Water Surface Elev. Change**
	47.1	480.0	2485+00	2.7		3.5	3903.7	0.8		1.9	0.1	**decrease**
	47.0	479.0	2480+00	2.9		3.4	3903.5	1.8		1.7	0.4	**<2 ft and >=0 ft increase**
	46.9	478.0	2475+00	3.4		3.9	3902.6	0.7		2.7	0.0	**>= 2 ft increase**
	46.8	477.0	2470+00	3.5		0.7	3902.0	3.5		2.5	-0.1	
	46.7	476.0	2465+00	3.2		2.0	3901.8	3.0		2.3	0.0	
	46.6	475.0	2460+00	3.8		0.6	3901.4	2.8		2.6	-0.1	
	46.5	474	2455+00	3.3		3.0	3901.2	2.5		2.6	0.0	
	46.4	473	2450+00	4.2		2.7	3900.4	2.8		3.3	0.0	
	46.3	472	2445+00	3.7		2.3	3900.2	2.7		2.3	0.0	
	46.2	471	2440+00	3.7		2.7	3899.7	2.8		2.7	0.0	
	46.1	470.0	2435+00	4.2		3.3	3898.6	2.7		3.7	0.0	
	46.0	469	2430+00	4.8		2.6	3898.0	2.6		3.8	0.0	
	45.9	468	2425+00	4.9		2.8	3897.0	2.4		4.4	0.0	
	45.8	467	2420+00	4.1		2.2	3896.7	2.2		3.6	0.0	
Picacho Bridge (U.S. 70, 80, 180)		466.5		7.4		2.7	3896.1	2.9		7.3	0.0	
		466.4		7.4		3.0	3896.1	3.1		7.3	0.0	
		466.3		7.6		3.0	3895.9	3.1		7.5	0.1	
		466.2		7.6		2.8	3895.9	3.0		7.5	0.1	
	45.5	466	2405+00	2.8		2.9	3895.2	2.5		3.9	0.1	
	45.5	465.0	2400+00	3.2		2.6	3895.1	1.3		2.9	0.1	
	45.4	464	2395+00	3.3		2.4	3894.9	2.3		2.9	0.1	
	45.3	463	2390+00	3.4		2.6	3894.6	2.0		2.8	0.1	
	45.2	462.0	2385+00	3.2		2.8	3894.2	1.1		2.6	0.2	**Levee Freeboard**
	44.9	461		2.9		2.5	3894.1	2.4		2.5	0.2	**<3 ft and > 1 ft**
	45.0	460.0	2375+00	2.4		2.5	3893.9	2.4		2.8	0.3	**<=1 ft and > 0 ft**
	44.9	459	2370+00	2.5		2.6	3893.6	2.4		2.2	0.3	**<= 0 ft**
	44.8	458	2365+00	1.8		2.5	3893.4	2.4		2.1	0.4	
Wasteway 10	44.7	457.0	2360+00	2.1		2.9	3892.7	0.5		1.9	0.1	**Edge Velocity**

Table C.2 Hydraulic Modeling Results for Cross Sections

				West Side, (Right Looking Downstream)				East Side, (Left Looking Downstream)				
	Miles North of American Dam	Cross Section Number	Station Number	Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)	
	44.6	456.0	2355+00	1.8		3.1	3892.4	1.8		2.3	0.2	<=4 ft/s and > 3 ft/s
Las Cruces Management Unit	44.5	455.0	2350+00	1.7		3.0	3891.9	0.6		1.9	-0.1	> 4 ft/s
Lower Mesilla Mangement Unit	44.4	454.0	2345+00	1.6		2.4	3891.8	1.5		1.4	0.0	
Interstate 10		453.5		2.7		2.4	3891.5	2.5		2.9	0.1	Water Surface Elev. Change
		453.4		2.7		2.6	3891.5	2.7		2.9	0.1	decrease
		453.3		2.8		2.6	3891.4	2.8		3.0	0.1	<2 ft and >=0 ft increase
		453.2		2.8		2.4	3891.4	2.5		3.0	0.1	>= 2 ft increase
	44.2	453	2335+00	2.3		2.2	3891.3	2.5		1.6	0.1	
	44.1	452	2330+00	1.2		2.2	3891.2	2.5		1.2	0.1	
	44.0	451	2325+00	1.7		2.5	3890.9	2.4		1.6	0.2	
	43.9	450.0	2320+00	1.6		2.4	3890.6	2.4		1.8	0.2	
	43.8	449	2315+00	2.0		2.4	3890.4	2.6		1.6	0.2	
	43.8	448	2310+00	2.3		2.6	3890.2	2.8		1.8	0.3	
	43.7	447	2305+00	2.6		2.2	3889.9	2.8		2.2	0.4	
	43.6	446	2300+00	2.8		2.2	3889.6	2.7		2.6	0.6	
	43.5	445	2295+00	2.9		2.1	3889.3	2.5		2.3	0.7	
Clark Lateral Site	43.4	444.0	2290+00	3.1		2.9	3888.7	0.6		2.1	0.4	
	43.3	443.0	2285+00	3.0		2.9	3888.2	0.6		2.0	0.4	
	43.2	442.0	POB 2278+92.32	3.0		3.0	3887.8	0.6		1.9	0.4	
	43.1	441.0	2275+00	2.9		2.8	3887.6	0.6		2.0	0.4	
	43.0	440.0	2270+00	2.6		2.9	3887.2	0.6		2.6	0.5	
	42.9	439.0	2265+00	2.7		2.7	3886.7	0.7		2.4	0.3	
	42.8	438.0	2260+00	2.5		2.6	3886.6	0.5		2.0	0.3	
	42.7	437.0	2255+00	1.3		1.7	3886.8	2.0		1.0	0.5	
	42.6	436.0	2250+00	1.3		1.7	3886.7	1.7		1.0	0.5	
	42.5	435.0	2245+00	1.6		2.6	3886.2	0.5		2.1	0.2	
Mesilla Bridge		434.5		2.8		1.6	3885.1	2.7		2.1	0.9	Levee Freeboard
		434.4		2.9		1.9	3885.1	3.2		2.1	1.0	<3 ft and > 1 ft
		434.3		2.9		1.9	3885.0	3.2		2.2	1.1	<=1 ft and > 0 ft
		434.2		2.9		1.6	3885.0	2.7		2.2	1.1	<= 0 ft
NMGF Site	42.1	434.0	2225+00	2.5		0.6	3884.3	0.7		2.0	0.9	
	42.0	433.0	2220+00	2.1		0.6	3884.0	0.7		1.7	0.9	Edge Velocity
	42.0	432.0	2215+00	2.6		0.7	3883.5	0.7		2.2	0.8	<=4 ft/s and > 3 ft/s
	41.9	431.0	2210+00	2.4		0.7	3883.1	0.7		1.9	0.8	> 4 ft/s

Table C.2 Hydraulic Modeling Results for Cross Sections

	Miles North of American Dam	Cross Section Number	Station Number	West Side, (Right Looking Downstream) Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	East Side, (Left Looking Downstream) Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)	
	41.8	430.0	2205+00	1.8		0.6	3882.9	0.6		1.2	0.8	
	41.7	429.0	2200+00	1.4		0.7	3882.6	0.7		1.1	0.7	Water Surface Elev. Change
	41.6	428.0	2195+00	1.7		0.7	3882.0	0.7		2.1	0.5	decrease
	41.5	427.0	2190+00	2.1		0.8	3881.6	0.7		2.1	0.4	<2 ft and >=0 ft increase
	41.4	426.0	2185+00	2.4		0.9	3880.7	0.7		3.0	-0.3	>= 2 ft increase
	41.3	425.0	2180+00	3.1		0.7	3880.6	0.6		2.3	-0.4	
	41.2	424.0	2175+00	-1.8		0.6	3880.6	0.5		2.5	-0.3	
	41.0	423	2165+00	9.4		1.6	3880.6	1.7		1.1	-0.2	
	40.9	422	2160+00	9.8		1.7	3880.5	1.6		1.3	-0.1	
	40.8	421	2155+00	9.9		1.8	3880.1	2.6		1.7	-0.2	
	40.7	420.0	2150+00	-2.3		0.4	3879.7	0.6		1.3	-0.5	
	40.6	419.0	2145+00	-4.5		0.5	3879.6	1.4		0.3	-0.6	
	40.5	418	2140+00	15.9		2.0	3879.3	2.4		1.2	-0.5	
	40.4	417	2135+00	13.1		1.1	3879.4	2.2		-0.2	-0.2	
	40.3	416	2130+00	24.0		0.8	3879.3	2.3		-0.9	-0.1	
	40.2	415	2125+00	32.5		1.4	3879.2	2.4		-1.1	-0.1	
	40.2	414	2120+00	27.6		1.5	3879.1	2.3		-0.3	0.0	
	39.8	413		2.5		1.1	3878.9	2.1		-0.3	-0.1	
	39.9	412	2105+00	34.2		1.1	3878.8	2.3		-0.1	0.0	
	39.8	411	2100+00	12.9		1.0	3878.7	2.3		-0.6	0.2	
	39.7	410.0	2095+00	20.1		0.6	3877.9	3.9		0.5	0.0	
	39.6	409	2090+00	18.2			3875.3	4.7		1.9	-0.1	
	39.5	408	2085+00	20.9		2.1	3875.3	3.7		1.7	-0.1	
	39.4	407	2080+00	15.1		1.6	3876.0	2.3		-1.2	0.3	
Mesilla Dam Site		406		2.2		7.7	3872.8	3.3		2.7	0.0	Levee Freeboard
		405.5		6.2			3868.8			5.5	0.0	<3 ft and > 1 ft
		405.4		6.7			3868.3			6.0	0.0	<=1 ft and > 0 ft
		405.3		6.8			3868.2			6.1	0.0	<= 0 ft
		405.2		6.7			3868.3			6.0	0.0	
	39.2	405	2070+00	5.2			3867.9	0.9		5.7	0.0	Edge Velocity
	39.1	404	2065+00	6.4		1.9	3867.6	1.2		5.6	0.0	<=4 ft/s and > 3 ft/s
	39.0	403	2060+00	6.6		2.5	3867.3	1.2		5.7	0.0	> 4 ft/s
	38.9	402	2055+00	5.8		2.5	3867.0	1.7		5.2	0.0	
	38.8	401	2050+00	5.0		2.2	3866.8	1.3		5.4	0.0	Water Surface Elev. Change

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Table C.2 Hydraulic Modeling Results for Cross Sections

				West Side, (Right Looking Downstream)				East Side, (Left Looking Downstream)				
	Miles North of American Dam	Cross Section Number	Station Number	Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)	
	38.7	400.0	2045+00	5.0		1.9	3866.6	1.0		5.1	0.0	decrease
	38.6	399	2040+00	5.7		2.3	3866.4	1.4		4.8	0.0	<2 ft and >=0 ft increase
	38.5	398	2035+00	4.7		2.7	3866.1	1.5		5.3	0.0	>= 2 ft increase
	38.4	397	2030+00	4.7		3.1	3865.8	2.0		5.4	0.0	
	38.4	396	2025+00	5.0		3.0	3865.6	2.1		5.0	0.0	
	38.3	395	2020+00	5.0		2.6	3865.4	2.1		4.6	0.0	
	38.2	394	2015+00	5.1		2.8	3865.0	2.3		4.2	0.0	
	38.1	393	2010+00	4.9		3.2	3864.5	2.4		4.5	0.0	
	38.0	392	2005+00	4.5		3.0	3864.3	2.2		3.9	0.0	
	37.9	391	2000+00	4.7		2.7	3864.1	2.4		3.7	0.0	
	37.8	390.0	1995+00	5.1		2.5	3863.8	2.8		3.4	0.0	
	37.6	389	1985+00	4.6		2.7	3863.2	2.6		3.6	0.0	
	37.5	388	1980+00	5.2		2.5	3862.6	2.3		3.9	0.0	
	37.4	387	1975+00	4.9		3.3	3862.4	2.6		3.4	0.0	
	37.3	386	1970+00	4.1		2.8	3862.2	2.8		3.3	0.0	
	37.2	385	1965+00	5.2		3.3	3861.3	3.2		4.1	0.0	
	37.1	384	1960+00	6.0		3.6	3860.4	3.3		5.3	0.0	
	37.0	383	1955+00	6.0		4.0	3859.6	3.1		5.2	0.0	
	36.9	382	1950+00	4.9		2.9	3859.9	2.4		4.4	0.0	
	36.8	381	1945 +00	5.7		2.6	3859.7	2.1		4.8	0.0	
	36.7	380.0	1940+00	4.9		2.6	3859.5	2.3		4.7	0.0	
	36.6	379	1935+00	4.3		2.3	3859.2	2.4		4.3	0.0	
Santo Tomas Bridge NM 28		378.6		5.3		2.0	3859.2	2.2		4.2	0.0	Levee Freeboard
		378.5		8.1		2.5	3859.1	2.7		7.1	0.0	<3 ft and > 1 ft
		378.4		8.1		2.9	3859.1	3.1		7.1	0.0	<=1 ft and > 0 ft
		378.3		8.1		2.9	3859.1	3.1		7.1	0.0	<= 0 ft
		378.2		8.1		2.5	3859.1	2.7		7.1	0.0	
	36.5	378	1925+00	6.4		2.4	3858.2	2.2		5.2	0.0	Edge Velocity
	36.4	377	1920+00	5.5		2.4	3858.1	2.5		4.2	0.0	<=4 ft/s and > 3 ft/s
	36.3	376	1915+00	6.2		2.7	3858.0	2.5		3.8	0.0	> 4 ft/s
	36.2	375	1910+00	5.0		3.0	3857.7	2.7		3.6	0.0	
	36.1	374	1905+00	4.6		3.1	3857.6	2.8		3.4	0.0	Water Surface Elev. Change
	36.0	373	1900+00	5.1		3.1	3857.3	2.7		3.6	0.0	decrease
	35.9	372	1895+00	5.2		3.3	3856.9	2.6		3.4	0.0	<2 ft and >=0 ft increase

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Table C.2 Hydraulic Modeling Results for Cross Sections

				West Side, (Right Looking Downstream)				East Side, (Left Looking Downstream)				
	Miles North of American Dam	Cross Section Number	Station Number	Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)	
	35.7	371	1885+00	6.1		3.2	3855.7	3.3		5.2	0.0	>= 2 ft increase
	35.6	370.0	1880+00	5.2		2.9	3855.7	3.0		4.5	0.0	
	35.5	369	1875+00	5.8		2.9	3855.2	2.9		5.1	0.0	
	35.4	368	1870+00	5.2		2.4	3854.8	2.9		5.1	0.0	
	35.3	367	1865+00	4.8		2.5	3854.6	3.1		4.3	0.0	
	35.2	366	1860+00	3.9		2.6	3854.4	2.9		3.8	0.0	
	35.1	365	1855+00	5.0		2.7	3853.8	3.1		5.0	0.0	
	35.0	364	1850+00	5.0		2.7	3853.5	2.8		5.1	0.0	
Pole Planting Area Site	34.9	363.0	1845+00	5.3		3.1	3852.5	0.6		5.9	0.0	
	34.8	362.0	1840+00	5.5		3.2	3852.0	2.1		6.1	0.0	
	34.8	361	1835+00	4.4		3.2	3852.1	3.4		4.3	0.0	
	34.7	360.0	1830+00	4.1		3.2	3851.7	3.3		4.4	0.0	
	34.6	359.0	1825+00	4.9		4.3	3850.5	0.9		5.1	0.0	
	34.5	358.0	1820+00	5.5		3.6	3850.3	0.7		5.5	0.0	
	34.4	357.0	1815+00	5.1		3.2	3850.1	0.6		5.0	0.0	
	34.3	356.0	1810+00	5.6		2.7	3849.8	0.6		5.0	0.0	
	34.2	355.0	1805+00	5.0		2.8	3849.2	0.6		4.9	0.0	
	34.1	354.0	1800+00	5.4		2.8	3848.6	0.7		5.8	0.0	
	34.0	353.0	1795+00	4.6		2.4	3848.5	0.6		5.1	0.0	
	33.9	352	1790+00	5.4		2.8	3848.3	2.8		4.8	0.0	
	33.8	351	1785+00	5.8		3.2	3847.4	2.1		6.2	0.0	**Levee Freeboard**
	33.7	350.0	1780+00	5.7		3.2	3847.2	2.3		6.1	0.0	<3 ft and > 1 ft
	33.6	349	1775+00	5.8		2.4	3846.9	2.8		5.3	0.0	<=1 ft and > 0 ft
	33.5	348		5.2		2.3	3846.3	2.8		5.7	0.0	<= 0 ft
	33.4	347	1765+00	4.7		2.7	3845.9	2.5		5.5	0.0	
	33.3	346	1760+00	5.7		2.9	3844.7	2.9		5.7	0.0	**Edge Velocity**
	33.2	345	1755+00	6.2		2.7	3844.3	2.7		6.2	0.0	<=4 ft/s and > 3 ft/s
	33.1	344.0	1750+00	6.1		1.8	3844.1	2.6		5.6	0.0	> 4 ft/s
	33.0	343	1745+00	5.7		2.3	3844.0	2.3		5.4	0.0	
	33.0	342	1740+00	5.7		1.9	3843.8	2.1		5.6	0.0	**Water Surface Elev. Change**
	32.9	341.0	1735+00	6.0		2.4	3843.5	1.2		5.4	0.0	decrease
	32.8	340.0	1730+00	6.0		2.0	3843.2	1.9		5.3	0.0	<2 ft and >=0 ft increase
	32.7	339	1725+00	5.7		1.4	3843.1	2.0		5.3	0.0	>= 2 ft increase
	32.6	338	1720+00	5.4		1.8	3842.7	1.6		5.8	0.0	

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Table C.2 Hydraulic Modeling Results for Cross Sections

	Miles North of American Dam	Cross Section Number	Station Number	West Side, (Right Looking Downstream) Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	East Side, (Left Looking Downstream) Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)
	32.5	337	1715+00	5.5		1.6	**3842.7**	1.3		5.4	**0.0**
Mesquite Bridge NM228		336.5		9.7		2.0	**3842.6**	1.0		9.5	**0.0**
		336.4		9.7		2.4	**3842.5**	1.2		9.6	**0.0**
		336.3		9.7		2.4	**3842.5**	1.2		9.6	**0.0**
		336.2		9.7		2.0	**3842.5**	1.0		9.6	**0.0**
	32.3	336.0	1705+00	5.3		1.3	**3842.3**	1.6		4.5	**0.0**
	32.2	335	1700+00	5.0		2.0	**3842.1**	1.7		4.0	**0.0**
	32.1	334	1695+00	4.8		2.7	**3841.6**	2.2		4.5	**0.0**
	32.0	333	1690+00	4.7		2.9	**3841.5**	2.4		4.1	**0.0**
	31.9	332.0	1685+00	5.8		3.0	**3840.7**	0.6		5.2	**0.0**
	31.8	331.0	1680+00	5.4		2.9	**3840.2**	0.8		4.7	**0.0**
	31.7	330.0	1675+00	4.7		2.3	**3839.7**	0.8		5.0	**0.0**
	31.6	329.0	1670+00	6.0		1.4	**3838.3**	0.9		6.0	**0.0**
	31.5	328.0	1665+00	5.7		0.8	**3838.2**	0.4		5.7	**0.0**
	31.3	327	1655+00	5.1		2.0	**3838.1**	2.0		4.1	**0.0**
	31.3	326	1650+00	5.0		2.4	**3837.5**	1.9		4.7	**0.0**
	31.2	325	1645+00	5.4		2.5	**3836.6**	3.1		5.4	**0.0**
	31.1	324	1640+00	6.0		3.0	**3836.4**	3.7		5.2	**0.0**
	31.0	323	1635+00	6.1		3.2	**3835.7**	3.7		5.3	**0.0**
	30.9	322	1630+00	5.9		2.9	**3835.3**	3.8		5.5	**0.0**
	30.8	321	1625+00	6.3		2.8	**3834.6**	3.7		5.6	**0.0**
	30.7	320.0	1620+00	5.7		2.8	**3834.3**	2.7		5.5	**0.0**
	30.6	319	1615+00	5.9		2.2	**3834.1**	2.2		5.2	**0.0**
	30.5	318	1610+00	5.6		2.2	**3833.9**	2.5		4.9	**0.0**
	30.4	317	1605+00	5.5		1.6	**3833.1**	3.2		5.7	**0.0**
	30.3	316	1600+00	6.4		1.5	**3833.0**	3.1		5.5	**0.0**
	30.2	315	1595+00	5.8		0.9	**3832.7**	3.2		5.3	**0.0**
	30.1	314	1590+00	4.3		2.3	**3832.4**	3.1		4.9	**0.0**
	30.0	313	1585+00	3.9		2.0	**3832.3**	2.7		4.7	**0.0**
	29.9	312	1580+00	4.2		1.7	**3831.7**	2.9		5.2	**0.0**
Wasteway No. 18 Site	29.8	311.0	1575+00	5.6			**3829.6**	0.8		6.7	**0.0**
	29.7	310.0	1570+00	4.1		2.7	**3830.3**	3.7		5.0	**0.0**
	29.6	309.0	1565+00	4.0		2.9	**3830.1**	2.8		4.4	**0.0**
	29.5	308.0	1560+00	3.7		2.3	**3829.9**	1.9		4.3	**0.0**

Levee Freeboard
- <3 ft and > 1 ft
- <=1 ft and > 0 ft
- <= 0 ft

Edge Velocity
- <=4 ft/s and > 3 ft/s
- > 4 ft/s

Water Surface Elev. Change
- decrease
- <2 ft and >=0 ft increase
- >= 2 ft increase

Table C.2 Hydraulic Modeling Results for Cross Sections

	Miles North of American Dam	Cross Section Number	Station Number	West Side, (Right Looking Downstream) Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	East Side, (Left Looking Downstream) Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)	
	29.5	307.0		3.9		2.1	3829.8	1.6		4.2	0.0	
	29.4	306.0	1550+00	4.1		1.6	3829.7	2.4		4.1	0.0	
	29.3	305.0	1545+00	4.9		2.1	3828.9	0.5		5.2	0.0	
Wasteway 106	29.2	304	1540+00	4.2		2.2	3828.8	2.2		4.1	0.0	
	29.1	303	1535+00	4.1		2.4	3828.5	2.1		4.5	0.0	
	29.0	302	1530+00	4.7		2.8	3828.1	2.3		4.9	0.0	
	28.9	301	1525+00	4.4		3.0	3827.7	2.4		4.3	0.0	
	28.8	300.0	1520+00	4.2		3.1	3827.4	2.4		4.6	0.0	
	28.7	299	1515+00	4.1		3.0	3827.2	2.1		4.4	0.0	
	28.6	298	1510+00	4.0		2.9	3827.0	2.3		4.0	0.0	
	28.5	297	1505+00	3.9		2.9	3826.7	1.9		3.7	0.0	
Old Channel Site	28.4	296.0	1500+00	3.3		0.7	3826.0	0.4		3.9	0.0	
	28.3	295.0	1495+00	3.3		0.6	3825.6	0.4		3.9	0.0	
	28.2	294.0	1490+00	3.4		0.7	3825.0	0.5		3.6	0.0	
	28.1	293.0	1485+00	3.9		0.5	3824.0	0.4		4.1	0.0	
	28.0	292.0	1480+00	3.8		0.6	3823.6	0.5		4.3	0.0	
Vado Bridge	27.9	291.0	1475+00	4.0		0.7	3823.2	0.6		3.7	-0.1	**Levee Freeboard**
		290.60		3.8		0.7	3823.0	0.6		3.5	0.0	**<3 ft and > 1 ft**
		290.5		3.9		2.2	3822.9	2.9		3.8	-0.1	**<=1 ft and > 0 ft**
		290.4		3.5		2.7	3822.9	3.5		3.8	-0.1	**<= 0 ft**
		290.3		3.5		2.7	3822.9	3.5		3.8	-0.1	
		290.2		3.5		2.2	3822.9	2.9		3.8	-0.1	**Edge Velocity**
	27.7	290.0	1460+00	2.4		2.2	3822.6	2.4		2.5	-0.1	**<=4 ft/s and > 3 ft/s**
	27.6	289	1455+00	2.0		2.4	3822.3	2.4		2.5	-0.1	**> 4 ft/s**
	27.5	288	1450+00	1.9		2.3	3822.1	2.4		1.5	-0.1	
	27.4	287	1445+00	1.4		2.6	3822.0	1.8		2.0	-0.1	**Water Surface Elev. Change**
Del Rio Drain Site	27.3	286.0	1440+00	1.9		0.7	3821.4	3.1		1.9	-0.1	**decrease**
	27.2	285.0	1435+00	1.1		0.6	3821.1	3.1		2.1	-0.1	**<2 ft and >=0 ft increase**
	27.1	284.0	POE 1428+49.55	1.2		0.6	3820.6	2.6		1.4	-0.2	**>= 2 ft increase**
	26.9	283.0	1420+00	1.1		0.6	3820.3	2.5		-1.3	0.5	
	26.8	282.0	1415+00	2.0		0.8	3819.4	0.7		4.0	0.0	
	26.7	281.0	1410+00	3.0		0.7	3818.3	0.5		4.0	0.0	
	26.6	280.0	1405+00	3.3		0.7	3818.1	0.3		3.7	0.0	
	26.5	279	1400+00	3.4		2.6	3818.2	1.8		1.2	0.0	

Table C.2 Hydraulic Modeling Results for Cross Sections

	Miles North of American Dam	Cross Section Number	Station Number	West Side, (Right Looking Downstream) Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	East Side, (Left Looking Downstream) Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)
	26.4	278	1395+00	4.0		2.9	3817.9	2.3		2.6	0.0
	26.3	277	1390+00	3.1		3.1	3817.7	0.9		3.5	0.0
	26.2	276	1385+00	3.3		3.2	3817.3	0.9		3.5	0.0
Wasteway No. 19 Site	26.1	275.0	1380+00	3.7		0.7	3816.5	0.5		3.7	0.0
Wasteway 108	26.0	274.0	1375+00	3.9		0.7	3816.1	0.6		3.1	0.0
	25.9	273.0	1370+00	4.6		0.8	3815.1	0.6		3.2	0.0
	25.9	272.0	1365+00	4.6		0.8	3814.6	0.4		3.2	0.0
	25.8	271.0	1360+00	4.4		0.6	3814.2	0.6		2.4	0.0
	25.7	270.0	1355+00	3.8		2.6	3814.4	2.5		2.8	0.0
	25.6	269	1350+00	4.0		2.9	3814.2	2.7		4.3	0.0
	25.5	268	1345+00	3.1		2.7	3814.0	2.3		2.8	0.0
	25.4	267	1340+00	3.8		2.5	3813.8	2.3		2.6	0.0
	25.3	266	1335+00	3.6		3.0	3813.5	2.5		2.7	0.0
	25.2	265	1330+00	3.2		3.1	3813.2	2.6		2.2	0.0
	25.1	264	1325+00	2.9		3.0	3812.7	2.2		2.8	0.0
	25.0	263	1320+00	3.2		2.4	3812.5	2.9		2.5	0.0
	24.9	262	1315+00	2.7		1.8	3812.5	2.7		2.1	0.0
	24.8	261	1310+00	2.6		1.6	3812.4	2.8		1.3	0.0
	24.7	260.0	1305+00	3.7		1.5	3812.0	2.7		2.0	0.0
	24.6	259	1300+00	3.4		2.1	3811.9	2.7		2.4	0.0
	24.5	258	1295+00	3.5		2.4	3811.7	2.5		2.3	0.0
	24.4	257	1290+00	3.7		2.3	3811.2	2.7		2.2	0.0
	24.3	256	1285+00	3.7		1.9	3810.6	3.3		2.5	0.0
	24.2	255	1280+00	2.5		2.7	3810.3	3.0		2.4	0.0
	24.1	254	1275+00	2.4		2.3	3809.9	3.4		1.5	0.0
Bernino Bridge		253.5		3.9		3.4	3809.1	3.2		3.5	0.0
		253.4		3.9		4.5	3809.1	4.1		3.4	0.0
		253.3		4.0		4.5	3808.9	4.2		3.6	0.0
		253.2		4.9		3.4	3808.1	3.3		4.4	0.0
	24.0	253	1265+00	4.6		3.0	3807.1	2.6		3.9	0.0
	23.9	252	1260+00	3.2		2.8	3807.0	2.5		3.4	0.0
	23.8	251	1255+00	3.2		2.6	3806.9	3.0		2.9	0.0
	23.7	250.0	1250+00	3.0		2.7	3806.7	3.0		2.4	0.0
	23.6	249	1245+00	3.2		2.6	3806.5	2.9		3.4	0.0

Levee Freeboard
- <3 ft and > 1 ft
- <=1 ft and > 0 ft
- <= 0 ft

Edge Velocity
- <=4 ft/s and > 3 ft/s
- > 4 ft/s

Water Surface Elev. Change
- decrease
- <2 ft and >=0 ft increase
- >= 2 ft increase

J:\736620\Alternatives Evaluation_4.7 Perform hydrologic Modeling (Version 7)\TableC2.xls\Whole River

Table C.2 Hydraulic Modeling Results for Cross Sections

	Miles North of American Dam	Cross Section Number	Station Number	West Side, (Right Looking Downstream) Free-board (ft)	West Side Levee	West Side Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	East Side, (Left Looking Downstream) Edge Velocity (ft/s)	East Side Levee	East Side Free-board (ft)	Water Elev. Change (ft)	
	23.5	248	1240+00	2.9		2.7	3806.3	2.8		3.1	0.0	
	23.4	247.0	1235+00	3.8		2.3	3805.2	2.0		3.8	0.0	
	23.3	246	1230+00	3.1		2.8	3805.1	3.0		4.3	0.0	
	23.2	245	1225+00	3.5		2.2	3804.8	2.9		3.3	0.0	
	23.1	244	1220+00	2.2		2.5	3804.7	2.6		2.3	0.0	
	23.0	243	1215+00	2.1		3.3	3804.3	3.0		2.3	0.0	
	22.9	242	1210+00	2.1		2.8	3804.0	2.9		1.9	0.0	
	22.8	241	1205+00	1.5		2.4	3803.8	2.9		2.3	0.0	
	22.7	240.0	1200+00	1.6		2.6	3803.6	2.8		2.6	0.0	
	22.6	239	1195+00	1.5		2.7	3803.5	2.6		2.3	0.0	
	22.5	238	1190+00	2.2		3.0	3803.1	2.6		1.6	0.0	
	22.4	237	1185+00	2.9		3.1	3802.8	2.6		2.7	0.0	
	22.3	236	1180+00	2.7		3.7	3802.4	2.2		2.3	0.0	**Levee Freeboard**
	22.3	235	1175+00	2.2		3.5	3802.0	1.9		1.7	0.0	**<3 ft and > 1 ft**
	22.2	234	1170+00	2.3		3.1	3801.7	2.5		2.3	0.0	**<=1 ft and > 0 ft**
Wasteway Nos. 31 and 20 Site	22.1	233.0	1165+00	2.9		2.0	3801.0	0.6		2.3	0.0	**<= 0 ft**
Wasteway 110	22.0	232.0	1160+00	1.9		1.9	3800.8	0.7		1.6	0.0	
	21.9	231.0	1155+00	4.5		0.7	3799.4	0.9		2.8	0.0	**Edge Velocity**
Wasteway 111	21.8	230.0	1150+00	4.4		0.5	3799.3	2.2		2.5	0.0	**<=4 ft/s and > 3 ft/s**
	21.7	229	1145+00	1.4		2.8	3799.3	3.0		1.5	0.0	**> 4 ft/s**
	21.6	228	1140+00	1.9		2.6	3798.9	2.7		1.3	0.0	
	21.5	227	1135+00	1.7		2.8	3798.7	2.5		2.2	0.0	**Water Surface Elev. Change**
	21.4	226	1130+00	1.6		2.4	3798.5	2.2		4.2	0.0	**decrease**
	21.3	225	1125+00	1.1		2.8	3798.3	2.4		5.0	0.0	**<2 ft and >=0 ft increase**
	21.2	224	1120+00	0.9		2.8	3797.9	2.3		5.8	0.0	**>= 2 ft increase**
	21.1	223	1115+00	0.8		2.8	3797.7	2.1		4.2	0.0	
Old Anthony Bridge		222.5		6.9		3.3	3796.9	3.6		6.2	0.0	
		222.4		6.9		3.7	3796.9	4.1		6.2	0.0	
		222.3		7.0		3.8	3796.8	4.1		6.3	0.0	
		222.2		7.0		3.4	3796.8	3.6		6.3	0.0	
	20.8	222	1100+00	3.6		2.7	3796.2	3.6		4.9	0.0	
	20.7	221	1095+00	2.2		3.0	3795.8	3.4		3.5	0.0	
	20.6	220.0	1090+00	2.5		2.8	3795.5	2.4		2.3	0.0	
	20.5	219	1085+00	2.1		3.2	3795.2	2.0		2.1	0.0	

Table C.2 Hydraulic Modeling Results for Cross Sections

	Miles North of American Dam	Cross Section Number	Station Number	West Side, (Right Looking Downstream) Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	East Side, (Left Looking Downstream) Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)
	20.5	218	1080+00	2.2		3.3	3794.8	2.1		2.5	0.1
	20.4	217	1075+00	2.0		2.8	3794.7	2.4		1.8	0.1
	20.3	216	1070+00	2.0		2.9	3794.3	2.8		1.7	0.1
	20.2	215	1065+00	3.1		2.6	3794.0	2.4		4.4	0.1
	20.1	214	1060+00	3.2		1.8	3793.5	2.0		2.3	0.2
	20.0	213	1055+00	2.7		1.9	3793.3	2.0		1.5	0.2
	19.9	212	1050+00	3.1		2.0	3793.1	2.7		1.1	0.2
	19.8	211	1045+00	4.0		1.8	3792.8	3.1		1.8	0.2
Jimenez and Three Saints Lateral	19.7	210.0	1040+00	3.6		1.0	3792.2	1.7		1.1	0.1
	19.6	209.0	1035+00	2.0		1.2	3792.1	1.6		1.1	0.0
	19.5	208	1030+00	1.7		1.8	3792.1	2.4		1.8	0.1
	19.4	207	1025+00	1.8		2.1	3791.9	2.3		5.2	0.1
	19.3	206	1020+00	1.4		2.3	3791.7	2.4		5.2	0.1
Lower Mesilla Mangement Unit	19.2	205	1015+00	2.1		2.5	3791.0	2.1		4.3	0.2
New Anthony Bridge		203.6		2.1		2.5	3791.0	2.2		3.3	0.2
El Paso Management Unit		203.5		3.5		3.6	3790.4	3.2		5.1	0.3
		203.4		3.8		4.4	3790.1	4.0		5.4	0.4
		203.3		4.1		4.5	3789.9	4.1		5.7	0.7
		203.2		4.0		3.9	3789.9	3.4		5.6	0.7
		203.1		2.3		2.9	3789.8	2.6		1.5	0.8
	19.0	203	1005+00	2.3		2.9	3789.7	2.6		1.6	1.0
Wasteway 114	18.9	202.0	1000+00	2.7		0.7	3789.1	2.4		1.9	0.7
	18.8	201.0	990+00	2.0		2.1	3789.0	2.2		1.2	0.8
	18.7	200.0	985+00	2.1		2.9	3788.9	2.1		1.3	1.0
		199		1.2		2.4	3788.8	1.9		1.4	1.1
	18.6	198.0	980+00	1.5		1.9	3788.5	0.6		1.3	0.9
	18.5	197.0	975+00	2.3		2.2	3788.1	0.7		1.7	0.8
	18.4	196.0	970+00	1.6		2.3	3787.6	0.8		1.9	0.6
	18.3	195.0	965+00	2.5		0.8	3786.9	0.8		2.5	0.1
	18.2	194.0	960+00	2.2		0.8	3785.8	1.0		3.0	-0.7
	18.1	193.0	955+00	2.3		0.5	3786.3	2.6		3.0	0.4
	18.0	192.0	950+00	1.9		0.4	3786.2	2.0		2.0	0.7
	17.9	191.0	945+00	0.9		0.4	3786.1	1.6		1.5	0.8
	17.8	190.0	940+00	1.0		0.4	3786.0	1.5		2.0	1.1

Levee Freeboard
- <3 ft and > 1 ft
- <=1 ft and > 0 ft
- <= 0 ft

Edge Velocity
- <=4 ft/s and > 3 ft/s
- > 4 ft/s

Water Surface Elev. Change
- decrease
- <2 ft and >=0 ft increase
- >= 2 ft increase

Table C.2 Hydraulic Modeling Results for Cross Sections

	Miles North of American Dam	Cross Section Number	Station Number	West Side, (Right Looking Downstream) Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	East Side, (Left Looking Downstream) Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)	
	17.7	189.0	935+00	1.2		0.4	**3785.8**	1.6		1.8	**1.4**	
	17.6	188.0	930+00	0.9		0.4	**3785.7**	2.1		2.5	**1.9**	
East Drain Site	17.5	187.0	925+00	1.8		0.7	**3784.9**	0.8		2.7	**1.3**	
	17.4	186.0	920+00	1.7		0.7	**3784.9**	0.7		3.0	**1.5**	
	17.3	185.0	915+00	1.8		0.7	**3784.7**	0.6		2.3	**1.5**	
	17.2	184.0	910+00	1.3		0.7	**3784.4**	0.7		2.2	**1.3**	
	17.1	183.0	905+00	1.5		0.9	**3784.0**	0.8		2.5	**1.0**	
	17.0	182.0	900+00	1.0		0.8	**3783.7**	2.1		3.1	**0.9**	
	17.0	181.0	895+00	1.5		0.7	**3783.6**	2.0		2.8	**1.0**	**Levee Freeboard**
	16.9	180.0	890+00	1.8		0.5	**3783.6**	1.7		2.8	**1.0**	**<3 ft and > 1 ft**
	16.8	179.0	885+00	1.3		0.6	**3783.4**	1.9		3.1	**1.0**	**<=1 ft and > 0 ft**
	16.7	178.0	880+00	2.0		0.8	**3783.0**	2.2		3.3	**0.8**	**<= 0 ft**
	16.6	177.0	875+00	2.4		1.0	**3782.0**	1.0		3.4	**0.1**	
	16.5	176.0	870+00	2.4		0.8	**3781.9**	0.7		3.3	**0.1**	**Edge Velocity**
Wasteway 117	16.4	175.0	865+00	1.8		0.6	**3782.0**	1.4		3.4	**0.2**	**<=4 ft/s and > 3 ft/s**
	16.2	174.0	855+00	1.9		0.8	**3781.4**	0.7		3.9	**-0.3**	**> 4 ft/s**
Wasteway 118	16.1	173	850+00	1.6		2.4	**3781.6**	2.1		2.6	**0.0**	
	16.0	172	845+00	1.8		2.8	**3781.4**	2.2		2.2	**0.0**	**Water Surface Elev. Change**
	15.9	171	840+00	2.4		2.8	**3781.3**	2.1		2.4	**0.0**	**decrease**
	15.8	170.0	835+00	2.5		3.0	**3781.2**	2.5		1.8	**0.0**	**<2 ft and >=0 ft increase**
Vinton Bridge	15.7	169		2.1		2.8	**3781.1**	2.4		0.9	**0.0**	**>= 2 ft increase**
		168.5		1.3		3.5	**3780.5**	2.8		2.5	**0.0**	
		168.4		1.3		3.9	**3780.6**	3.3		2.5	**0.0**	
		168.3		1.3		3.9	**3780.5**	3.4		2.5	**0.0**	
		168.2		1.3		3.5	**3780.5**	2.8		2.5	**0.0**	
	15.6	167	825+00	1.7		2.7	**3780.4**	1.9		3.3	**0.0**	
	15.5	166	820+00	2.3		3.4	**3779.9**	1.2		5.3	**0.0**	
	15.4	165	815+00	2.7		3.0	**3779.3**	1.7		5.7	**0.0**	
	15.3	164	810+00	2.2		3.4	**3779.2**	1.5		6.4	**0.0**	
	15.2	163	805+00	2.2		3.5	**3779.0**	2.1		6.9	**0.0**	
	15.2	162	800+00	1.1		3.1	**3778.9**	2.6		8.3	**0.0**	
	15.1	161	795+00	1.2		3.1	**3778.7**	2.5		9.0	**0.0**	
	15.0	160.0	790+00	0.7		2.7	**3778.4**	2.2		8.6	**0.0**	
	14.9	159	785+00	2.4		3.4	**3777.3**	1.4		8.4	**0.0**	

Table C.2 Hydraulic Modeling Results for Cross Sections

	Miles North of American Dam	Cross Section Number	Station Number	West Side, (Right Looking Downstream) Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	East Side, (Left Looking Downstream) Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)
	14.8	158	780+00	1.0		3.1	3777.3	2.4		8.3	0.0
	14.7	157	775+00	1.1		2.8	3777.2	2.3		6.9	0.0
	14.6	156	770+00	1.2		2.7	3777.1	1.8		7.0	0.0
Wasteway 120	14.5	155.0	765+00	1.8		4.0	3776.3	1.2		7.5	0.0
	14.4	154	760+00	1.7		3.1	3776.0	1.9		7.3	0.0
	14.3	153	755+00	1.5		2.8	3776.1	1.9		6.2	0.0
	14.2	152	750+00	2.1		3.9	3775.2	2.2		7.4	0.0
	14.1	151	745+00	2.5		4.5	3774.3	1.9		8.5	0.0
	14.0	150	740+00	2.1		4.5	3773.9	1.8		8.3	0.0
	13.9	149	735+00	1.8		3.9	3773.5	2.2		7.5	0.0
	13.8	148.0	730+00	2.5		2.2	3773.3	2.4		5.6	-0.1
	13.7	147	725+00	1.8		3.1	3773.2	2.4		4.8	-0.1
	13.6	146	720+00	1.4		2.9	3772.9	2.2		6.7	-0.1
	13.5	145	715+00	1.9		3.4	3772.5	1.8		8.4	-0.1
	13.4	144	710+00	1.7		3.3	3772.3	2.0		7.8	-0.1
	13.4	143	705+00	1.6		2.8	3772.3	2.4		4.6	-0.1
	13.3	142	700+00	1.0		2.8	3772.2	2.5		1.1	-0.1
Wasteway 124	13.2	141.0	695+00	1.4		2.2	3771.5	1.6		-0.2	-0.5
	13.1	140.0	690+00	0.6		2.9	3771.5	1.8		-1.6	-0.4
	13.0	139	685+00	0.3		2.4	3771.4	1.9		-2.1	-0.3
Wasteway 125	12.9	138	680+00	0.5		2.5	3771.3	1.8		-2.3	-0.2
	12.8	137	675+00	0.2		2.4	3771.1	2.0		-2.1	-0.2
Canutillo Bridge		135.6		0.0		2.4	3770.9	2.0		-2.6	-0.1
		135.3		-2.4		1.8	3770.5	1.4		-2.3	-0.5
		135.2		-0.9		2.0	3769.0	2.7		-0.8	-0.5
		135.1		1.9		2.4	3769.0	2.6		-1.1	-0.5
	12.6	135	665+00	2.2		2.5	3768.6	2.6		0.3	-0.6
	12.4	134	655+00	2.5		3.2	3767.8	2.2		0.5	-1.0
	12.3	133	650+00	2.3		2.8	3767.9	2.2		-0.2	-0.6
	12.2	132	645+00	1.7		1.8	3768.0	1.9		-1.0	-0.5
	12.1	131	640+00	1.8		1.4	3767.9	1.7		-0.6	-0.4
	12.0	130.0	635+00	1.7		3.1	3767.3	3.0		0.3	-0.8
		129		1.2		1.8	3767.5	1.6		-0.8	-0.5
	11.9	128	630+00	1.4		2.0	3767.4	1.6		-1.1	-0.5

Levee Freeboard

- <3 ft and > 1 ft
- <=1 ft and > 0 ft
- <= 0 ft

Edge Velocity

- <=4 ft/s and > 3 ft/s
- > 4 ft/s

Water Surface Elev. Change

- decrease
- <2 ft and >=0 ft increase
- >= 2 ft increase

J:\736620\Alternatives Evaluation_4.7 Perform hydrologic Modeling (Version 7)\TableC2.xls\Whole River

Table C.2 Hydraulic Modeling Results for Cross Sections

	Miles North of American Dam	Cross Section Number	Station Number	West Side, (Right Looking Downstream) Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	East Side, (Left Looking Downstream) Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)	
	11.8	127	625+00	1.4		1.8	**3767.3**	1.6		-1.1	**-0.3**	
	11.7	126.0	620+00	1.2		1.6	**3767.0**	0.7		-0.8	**-0.5**	
	11.6	125	615+00	0.7		1.7	**3767.1**	1.3		-1.9	**-0.4**	
	11.6	124	610+00	0.5		1.6	**3767.1**	1.2		-2.3	**-0.4**	
	11.5	123	605+00	0.0		1.4	**3767.0**	0.9		-2.2	**-0.3**	**Levee Freeboard**
	11.4	122.0	600+00	-0.5		1.2	**3766.9**	0.3		-2.3	**-0.3**	**<3 ft and > 1 ft**
	11.3	121	595+00	-0.2		1.0	**3766.9**	1.1		-3.2	**-0.1**	**<=1 ft and > 0 ft**
	11.2	120.0	590+00	-0.2		1.1	**3766.9**	1.1		-2.2	**0.0**	**<= 0 ft**
	11.1	119	585+00	-1.6		1.1	**3766.9**	1.1		-2.2	**0.2**	
Wasteway No. 34 Site	11.0	118.0	580+00	-1.5		1.3	**3766.6**	0.3		-2.9	**0.1**	**Edge Velocity**
	10.9	117.0	575+00	-1.8		1.0	**3766.6**	0.4		-2.6	**0.1**	**<=4 ft/s and > 3 ft/s**
	10.8	116	570+00	-0.9		1.1	**3766.6**	1.0		-3.4	**0.1**	**> 4 ft/s**
	10.7	115	565+00	-1.8		1.2	**3766.5**	1.1		-3.4	**0.3**	
Borderland Bridge		114.4		-1.3		2.3	**3766.3**	2.1		-3.2	**0.0**	**Water Surface Elev. Change**
		114.3		-1.2		2.0	**3766.2**	1.4		-1.5	**0.0**	**decrease**
		114.2		1.5		2.9	**3763.5**	2.4		1.2	**0.1**	**<2 ft and >=0 ft increase**
		114.1		1.7		3.2	**3763.2**	2.4		1.8	**0.1**	**>= 2 ft increase**
		114		2.8		4.0	**3762.5**	3.4		2.6	**0.1**	
	10.5	113	555+00	2.7		4.0	**3762.3**	3.3		2.1	**0.1**	
	10.4	112	550+00	3.0		3.6	**3761.9**	3.2		2.1	**0.2**	
Wasteway 127 (formerly Montoya C	10.3	111.0	545+00	2.2		2.6	**3761.5**	4.1		2.2	**0.1**	
	10.1	110.0	535+00	2.6		3.2	**3761.2**	3.0		2.2	**0.1**	
	10.0	109	530+00	2.8		3.4	**3760.9**	2.5		2.4	**0.2**	
	9.9	108	525+00	2.1		3.2	**3760.7**	2.9		1.5	**0.2**	
		107		1.8		3.0	**3760.5**	2.8		1.8	**0.2**	
	9.8	106.0	520+00	2.0		1.7	**3760.3**	3.0		1.9	**0.2**	
	9.8	105	515+00	1.3		2.4	**3760.2**	2.6		1.8	**0.3**	
	9.7	104	510+00	1.1		2.5	**3760.0**	2.6		1.2	**0.3**	
	9.6	103	505+00	1.3		2.8	**3759.7**	3.0		1.5	**0.4**	
	9.5	102	500+00	1.6		3.2	**3759.4**	3.1		1.6	**0.4**	
	9.4	101	495+00	1.6		3.4	**3759.1**	3.4		1.7	**0.6**	
Wasteway No. 35 Site	9.3	100.0	490+00	1.7		2.5	**3758.1**	0.9		1.7	**-0.2**	
	9.2	99.0	485+00	1.8		2.2	**3758.0**	3.7		2.0	**0.0**	
	9.1	98	480+00	1.7		3.3	**3757.8**	3.2		1.5	**0.1**	

Table C.2 Hydraulic Modeling Results for Cross Sections

	Miles North of American Dam	Cross Section Number	Station Number	West Side, (Right Looking Downstream) Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	East Side, (Left Looking Downstream) Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)
	9.0	97	475+00	1.6		3.2	3757.6	3.1		1.4	0.1
	8.9	96	470+00	1.7		2.9	3757.3	3.2		1.5	0.1
	8.8	95	465+00	1.8		3.1	3757.0	3.1		1.7	0.1
	8.7	94	460+00	1.5		3.0	3756.8	2.9		1.5	0.1
	8.6	93		1.6		2.8	3756.6	2.9		1.2	0.1
	8.5	92	450+00	1.6		3.0	3756.3	3.1		1.6	0.2
	8.4	91	445+00	1.6		3.2	3756.1	3.0		1.9	0.2
	8.3	90.0	440+00	1.9		2.8	3755.9	2.9		2.0	0.2
	8.2	89	435+00	1.4		3.0	3755.7	2.9		1.5	0.3
	8.1	88	430+00	1.6		3.1	3755.4	2.8		1.6	0.3
	8.0	87	425+00	1.7		3.2	3755.2	2.3		1.8	0.3
	8.0	86	420+00	1.3		3.3	3755.0	2.6		1.8	0.4
Country Club Bridge		85.6		1.3		2.9	3754.8	2.5		1.1	0.4
		85.5		0.9		3.2	3754.5	3.0		1.5	0.6
		85.4		0.9		3.5	3754.5	3.3		1.5	0.6
		85.3		1.2		3.6	3754.2	3.4		1.8	0.5
		85.2		1.2		3.3	3754.2	3.1		1.8	0.4
		85.1		1.5		2.7	3754.2	2.9		1.1	0.5
	7.8	85	410+00	0.9		2.7	3754.1	2.7		1.6	0.5
	7.7	84	405+00	1.1		2.6	3753.9	2.8		1.4	0.6
	7.6	83	400+00	1.2		2.9	3753.6	3.3		1.5	0.8
	7.5	82	395+00	0.9		2.2	3753.6	2.7		0.3	0.9
	7.4	81	390+00	1.1		1.8	3753.5	2.5		0.8	0.9
	7.3	80.0	385+00	1.1		2.0	3753.3	2.7		0.2	1.0
	7.2	79	380+00	0.8		2.5	3752.9	3.2		1.3	1.4
Newmexas Drain Siphon Site	7.1	78.0	375+00	0.0		0.4	3753.0	1.3		-0.1	1.3
	7.0	77.0	370+00	0.5		0.6	3752.6	0.7		0.5	0.9
	6.9	76.0	365+00	8.0		0.8	3752.1	0.8		0.8	0.5
	6.8	75.0	360+00	11.5		0.6	3752.0	0.6		0.8	0.5
	6.7	74	355+00	12.9		1.3	3752.1	2.3		0.2	0.8
	6.6	73	350+00	17.9		1.3	3752.0	2.3		0.3	0.8
	6.5	72	345+00	13.1		1.2	3752.0	2.2		0.5	0.9
	6.4	71	340+00	13.3		1.5	3751.7	2.6		1.1	1.0
	6.3	70.0	335+00	13.4		1.4	3751.6	2.3		1.2	1.0

Levee Freeboard	
<3 ft and > 1 ft	
<=1 ft and > 0 ft	
<= 0 ft	
Edge Velocity	
<=4 ft/s and > 3 ft/s	
> 4 ft/s	
Water Surface Elev. Change	
decrease	
<2 ft and >=0 ft increase	
>= 2 ft increase	

Table C.2 Hydraulic Modeling Results for Cross Sections

				West Side, (Right Looking Downstream)				East Side, (Left Looking Downstream)				
	Miles North of American Dam	Cross Section Number	Station Number	Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)	
	6.3	69	330+00	13.5		2.1	3751.5	2.4		0.3	1.1	Levee Freeboard
	6.2	68	325+00	10.9		1.8	3751.5	2.0		0.0	1.3	<3 ft and > 1 ft
	6.1	67	320+00	10.2		1.4	3751.4	2.3		-0.1	1.7	<=1 ft and > 0 ft
	6.0	66	315+00	10.3		1.3	3751.3	2.2		-0.2	1.8	<= 0 ft
Sunland Park Site	5.9	65.0	310+00	11.4		0.4	3751.0	1.9		-1.3	1.9	
	5.8	64.0	305+00	14.0		0.3	3749.2	0.9		0.4	1.2	Edge Velocity
	5.7	63.0	300+00	16.2		0.5	3748.6	1.0		1.3	1.4	<=4 ft/s and > 3 ft/s
	5.6	62.0	295+00	19.6		0.7	3748.4	0.9		0.6	1.3	> 4 ft/s
	5.5	61.0		10.9		0.7	3748.3	0.7		1.7	1.2	
	5.4	60.0		11.0		0.7	3748.1	0.7		2.2	1.1	Water Surface Elev. Change
	5.3	58.0	280+00	11.5		0.7	3747.5	0.7		1.7	0.8	decrease
	5.2	57.0	275+00	9.8		0.7	3746.6	0.8		1.5	0.4	<2 ft and >=0 ft increase
	5.1	56.0	270+00	4.2		0.8	3746.2	0.8		2.0	0.3	>= 2 ft increase
	5.0	55	265+00	7.4		2.1	3746.3	3.1		1.0	0.9	
	4.9	54	260+00	14.0		2.4	3746.3	2.5		1.2	1.0	
	4.8	53	255+00	12.1		2.2	3746.1	2.6		1.3	1.1	
	4.7	52	250+00	6.9		1.7	3745.8	2.9		1.0	1.5	
	4.6	51	245+00	12.3		1.7	3745.9	2.0		-0.2	1.7	
Cottonwood Grove Site	4.5	50.0	240+00	3.0		0.6	3745.2	0.7		0.3	1.3	
	4.5	49.0	235+00	7.1		0.4	3745.3	1.3		-0.1	1.6	
	4.4	48.0	230+00	13.4		0.4	3745.2	1.2		-0.6	1.6	
	4.3	47.0	225+00	6.2		0.5	3744.8	1.3		-0.1	1.6	
	4.1	46.0	POB 217+41.054	11.2		0.6	3744.2	0.8		0.3	1.1	
	4.0	45.0	210+00	2.1		0.6	3743.9	0.8		0.0	1.1	
	3.9	44.0	205+00	2.8		0.6	3743.6	0.8		-0.2	1.0	
	3.8	43.0	200+00	0.0		0.7	3742.1	1.0		1.9	0.0	
	3.7	42	195+00	12.4		2.0	3742.7	2.7		1.1	0.9	
	3.6	41	190+00	12.6		2.0	3742.5	2.5		0.9	1.0	
	3.5	40.0	185+00	11.9		2.1	3742.4	2.4		0.6	1.1	
	3.4	39	180+00	11.8		2.0	3742.4	2.2		0.7	1.2	
Anapra Bridge Site	3.3	38.0	175+00	13.4		0.8	3741.6	0.7		1.7	0.5	
	3.2	37.0	170+00	13.6		0.7	3741.4	0.7		1.5	0.3	
	3.1	36.0	165+00	13.9		0.7	3741.1	0.7		0.9	0.1	Levee Freeboard
	3.0	35.0	160+00	10.5		0.7	3740.6	0.8		1.5	-0.3	<3 ft and > 1 ft

Table C.2 Hydraulic Modeling Results for Cross Sections

				West Side, (Right Looking Downstream)				East Side, (Left Looking Downstream)				
	Miles North of American Dam	Cross Section Number	Station Number	Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)	
	2.9	34.0	155+00	3.7		0.7	3739.4	0.9		2.3	-1.3	<=1 ft and > 0 ft
	2.8	33	150+00	5.9		2.0	3739.6	3.1		1.4	-0.8	<= 0 ft
	2.7	32	145+00	9.3		2.3	3739.7	2.3		1.4	-0.7	
		31.5		8.7		2.6	3739.5	2.4		8.4	-0.8	Edge Velocity
		31.4		8.6		2.7	3739.5	2.6		8.4	-0.8	<=4 ft/s and > 3 ft/s
		31.3		8.6		2.7	3739.5	2.6		8.4	-0.8	> 4 ft/s
		31.2		8.7		2.6	3739.5	2.4		8.5	-0.8	
	2.5	28	130+00	12.8		1.8	3739.2	2.0		2.6	-0.9	Water Surface Elev. Change
	2.4	27		15.1		2.1	3739.1	1.8		2.5	-0.9	decrease
	2.3	26	120+00	22.8		2.1	3739.0	1.8		2.4	-0.9	<2 ft and >=0 ft increase
Newmexas Drain	2.2	25	115+00	6.8		2.0	3739.0	1.2		2.1	-0.9	>= 2 ft increase
	2.1	24		1.2		2.8	3738.6	2.0		2.0	-1.0	
	2.0	23	105+00	1.2		2.7	3738.3	2.9		1.9	-1.1	
	1.9	22	100+00	1.3		2.9	3738.3	3.1		1.9	-1.1	
	1.8	21	95+00	0.9		2.5	3738.3	2.1		-4.3	-0.6	
	1.7	20.0	90+00	2.0		2.4	3737.8	3.2		0.6	-1.1	
Courchesne Bridge		19.5		19.5		3.8	3736.8	4.0		13.5	-2.1	
		19.4		19.5		3.8	3736.8	4.0		13.5	-2.1	
		19.3		19.7		3.9	3736.6	4.1		13.7	-1.9	
		19.2		19.7		3.9	3736.6	4.1		13.7	-0.7	
	1.5	17	80+00	12.3		2.6	3736.8	2.5		28.6	-0.7	
	1.4	16	75+00	11.3		2.2	3736.7	2.6		13.4	-0.7	
	1.3	15	70+00	11.4		2.2	3736.6	2.4		11.7	-0.7	
	1.2	14.0	65+00	0.3		2.4	3736.4	2.5		2.8	-0.8	
	1.1	13	60+00	-0.4		1.8	3736.4	2.1		28.6	-0.6	
	1.0	12	55+00	-0.3		1.8	3736.4	1.3		25.5	-0.2	
	0.9	11	50+00	-0.1		1.9	3736.2	1.1		17.5	0.1	
	0.9	10.0	45+00	-0.8		2.2	3736.1	1.1		2.6	0.4	
	0.8	9	40+00	10.1		2.2	3735.9	1.4		1.4	0.0	
	0.7	8	35+00	10.9		1.7	3735.1	3.0		11.9	-0.1	
	0.6	7	30+00	11.0		2.7	3735.0	1.8		16.9	-0.1	Levee Freeboard
	0.5	6	25+00	11.3		2.8	3734.7	0.4		11.3	-0.1	<3 ft and > 1 ft
	0.4	5	20+00	11.5		3.3	3734.5	1.2		3.3	-0.1	<=1 ft and > 0 ft
TNORR Bridge	0.3	4	15+00	8.7		2.4	3734.6	2.6		4.2	-0.1	<= 0 ft

Table C.2 Hydraulic Modeling Results for Cross Sections

				West Side, (Right Looking Downstream)				East Side, (Left Looking Downstream)			
	Miles North of American Dam	Cross Section Number	Station Number	Free-board (ft)	Levee	Edge Velocity (ft/s)	Water Elev. Main Channel (ft)	Edge Velocity (ft/s)	Levee	Free-board (ft)	Water Elev. Change (ft)
SPRR Bridge		3.4		-1.2		1.4	**3734.4**	2.5		-1.4	**-0.1**
Brick Plant Bridge		3.3		-0.3		1.1	**3734.2**	2.4		-0.5	**-0.1**
		3.2		0.0		1.0	**3733.9**	2.4		-0.2	**0.0**
	0.1	2	5+00	0.0		1.7	**3733.8**	1.7		-0.8	**0.0**
American Dam	0.0	1	0+00	-0.4		0.4	**3733.8**	0.8		-0.2	**0.0**

Edge Velocity

<=4 ft/s and > 3 ft/s

> 4 ft/s

Water Surface Elev. Change

decrease

<2 ft and >=0 ft increase

>= 2 ft increase

APPENDIX D - COST ANALYSIS TABLES

Table D.1 Alternatives Definition

		Upper Rincon										Lower Rincon									Seldon Canyon			Upper Mesilla				
		Oxbow Restoration	Tipton Arroyo	Trujillo Arroyo	Montoya Arroyo	Holguin Arroyo	Green / Tierra Blanca Arroyos	Sibley Arroyo	Jaralosa Arroyo / Remnant Bosque	Yeso Arroyo	Crow Canyon / Channel Cut	Hatch Siphon	Wetlands Unit A	Wetlands Unit B	Garfield Drain	Placitas Arroyo	Remnant Bosque / Rincon Siphon	Angostura Arroyo	Rincon / Reed Arroyos	Bignell Arroyo.	Dead Mans Curve	Broad Canyon	Leasburg Dam	West Side	Levee Setback	Seldon Drain	Channel Cut	Wasteway No. 2A.
PROJECT FUNCTIONALITY (USIBWC MISSION)	**Unit**	**104.5**	**104**	**103**	**101.5**	**101**	**99.5**	**98**	**96.5**	**93.5**	**92**	**90**	**89**	**87**	**86**	**84.5**	**83**	**80**	**78**	**76**	**69**	**67**	**62**	**57.5**	**56.5**	**55.5**	**54.5**	**52**
Raise levees/add flood control structures	mile																1.1	0.9	0.4	0.7	5.8			0.4	0.9			0.3
Modify dredging at arroyos	event		1	1	1		2	1		2						1			1									
Modify spoil disposal locations/practices	1000 yd3		20	20	20		40	20		40						20			20									
Acquire flood easements and set back levees	acre																88	21						0	0			
Reduce dredging of pilot channel	1000 yd3																				100	100	250					
Reduce runoff entering river during floods																												
Erosion control/dams in tributaries	dam			1	1		1	1		1						1			2	1		1						
AQUATIC/RIPARIAN HABITAT ENHANCEMENTS																												
Mouth of Arroyos/Canyons																												
Retain/expand existing groin structures	unit			1	1	1				2						1			1									
Retain/expand existing weirs, embayments	unit			1	1		1	1											1									
Additional groin locations	unit	1	1			1	2		2		2				1			1						2	1	1		
Additional weir/embayment locations	unit	1	1		2	2	2	2	3	2	2				1			1	1	1				2	1			1
Create/expand wetlands	acre	1	1	2	2	2	2	2	5	2	2	2	10	10		2	2		2	12				4	1	2		
Widen Channel	acre		2	5	2					2	5																	
Water Diversion Structures & Siphons																												
Create white-water fish habitat	acre											2					1											
Provide back-water habitat	acre																1											
Wasteways/Drains																												
Reduced maintenance	acre								2	1					10											5		1
Enhance wetlands	acre				2				2	1					4	2										1		2
Riparian Vegetation Sites																												
Expand remnant bosques/riparian veg.	acre		8		5		3	0	50	20	30	4			5	10	10	10	5	5	0			60			20	
Control invasive vegetation (salt cedar)	acre	9	8	29	23	6	24	21	60	86	105	11	0	0	20	30	20	40	45	45	0	0	5	40	10	5	97	5
Planting sites within ROW	acre		0	10	5	20	20	10	20		20						10								10		10	1
Planting sites outside ROW	acre			10	20											20	20	10			5	10		0	0			
Land purchases for habitat	acre			74	55				355							132	109	43			59	47		0	25			
IBWC Land Management																												
Retain existing no-mow zones	acre	15	15	44																			5					
Additional no-mow zones (exluding leases)	acre				0				0	30		15			15	40	40	50	50	50					0			5
Discontinue leases	acre				40	28	50	33	150	90	200													100	20		150	
RESTORATION OF FLUVIAL PROCESSES																												
Old Channels & Oxbows																												
Channel splits ROW	acre	6			5		3	2	20	10	40																23	
Embayments within ROW	unit					2				2																		
Levee setback,	acre			0.75																								
Control invasive vegetation (salt cedar) outside	acre			30	35	0	0	0	315	0	0	0	0	0	0	112	89	33	0	0	34	37	0	0	20	0	0	0
New meanders outside ROW	acre			0																					5	0		
Bank overflow by shave downs	acre		5		5		8	5																			10	
Create/expand wetlands outside ROW	acre				20				40												20				5	0		
Flow Regime Modification																												
Allow seasonal peak flows		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1																	
Establish minimum in-stream flows		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MULTIPURPOSE PROJECT MANAGEMENT																												
Add recreational areas	acre																						4					
Interagency cooperation agreements																			1	1	1	1	1					
Improve water quality, water conservation	acre																											

Legend

Alternative 1
Alternative 2
Alternative 3
Alternative 4
Alternative 5

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Table D.1 Alternatives Definition

		Las Cruces				Lower Mesilla									El Paso									
		Wasteway No. 5	Wasteway No. 39	Wasteway No. 8	Wasteway No. 39A.	Clark Lateral	NMGF Bosque	Mesilla Dam	Pole Planting Area	Wasteway 18	Old Channel	Del Rio Drain	Wasteway 19	Wasteway 31 and Wasteway 20.	Jimenez & Three Saints West Drains.	East Drain / Border Steel.	Wasteway 34	Wasteway 35	Nemexas Drain	Sundland Park West Bank	Cottonwod Grove	Anapra Bridge		
PROJECT FUNCTIONALITY (USIBWC MISSION)	**Unit**	**50**	**48.5**	**47.5**	**46.6**	**42.5**	**41.5**	**39.5**	**34**	**29.5**	**28**	**26.5**	**25.5**	**22**	**19.5**	**16**	**10**	**9**	**7**	**5**	**4**	**3**	**Total**	**Unit**
Raise levees/add flood control structures	mile	1.4	0.4	2.1	0.9	2.1	5.3	1.0	0.4		1.4	1.3	0.7	5.0	4.9	6.8	8.3	9.3	2.0	2.7	2.5	0.9	69.9	mile
Modify dredging at arroyos	event																						10	event
Modify spoil disposal locations/practices	1000 yd3																						200	1000 yd3
Acquire flood easements and set back levees	acre										24												133	acre
Reduce dredging of pilot channel	1000 yd3																						450	1000 yd3
Reduce runoff entering river during floods																							0	
Erosion control/dams in tributaries	dam																						10	dam
AQUATIC/RIPARIAN HABITAT ENHANCEMENTS																								
Mouth of Arroyos/Canyons																								
Retain/expand existing groin structures	unit																						7	unit
Retain/expand existing weirs, embayments	unit																						5	unit
Additional groin locations	unit						2												1				18	unit
Additional weir/embayment locations	unit	1	1	2	1		2		1						2	0	1	1	1				38	unit
Create/expand wetlands	acre					10	5						3	5	1	0			1				93	acre
Widen Channel	acre																						16	acre
Water Diversion Structures & Siphons																								
Create white-water fish habitat	acre																						3	acre
Provide back-water habitat	acre							10															11	acre
Wasteways/Drains																								
Reduced maintenance	acre	1	1	15			40	0		5			8	5	5	2	0	5	4	44			154	acre
Enhance wetlands	acre	2	2	3	1		4			2	2		1	1	1	2	0	1					36	acre
Riparian Vegetation Sites																								
Expand remnant bosques/riparian veg.	acre					0		0	1										0		3		249	acre
Control invasive vegetation (salt cedar)	acre	9	11	14	6	15	40	0	4	10	11	15	8	5	35	4	0	13	24	54	30	10	1062	acre
Planting sites within ROW	acre	5	6	5		0			5	5	5	5				10	1	4		10	0		197	acre
Planting sites outside ROW	acre						30			5	5	5				10						10	160	acre
Land purchases for habitat	acre				16		114			24	36	35			0	25						34	1183	acre
IBWC Land Management																								
Retain existing no-mow zones	acre	2	3	4	1																		89	acre
Additional no-mow zones (exluding leases)	acre	11	13	0	5	0			10	10	16	20		0	10	12	1	12	20	20	33		488	acre
Discontinue leases	acre					0									20								881	acre
RESTORATION OF FLUVIAL PROCESSES																								
Old Channels & Oxbows																								
Channel splits ROW	acre					0																	109	acre
Embayments within ROW	unit					0																	4	unit
Levee setback,	acre						1			0.8	1	0.5											4.1	acre
Control invasive vegetation (salt cedar) outside	acre	0	0	0	16	0	74	0	0	19	31	30	0	0	0	15	0	0	0	0	0	24	914	acre
New meanders outside ROW	acre						20			8	8	6											47	acre
Bank overflow by shave downs	acre																						33	acre
Create/expand wetlands outside ROW	acre						10																95	acre
Flow Regime Modification																								
Allow seasonal peak flows																							1	
Establish minimum in-stream flows		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	
MULTIPURPOSE PROJECT MANAGEMENT																								
Add recreational areas	acre																			10			14	acre
Interagency cooperation agreements																							5	
Improve water quality, water conservation	acre																						0	acre

Legend

Legend	Alternative 1
	Alternative 2
	Alternative 3
	Alternative 4
	Alternative 5

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Table D.5 Life Cycle Costs ($ Million)

	Upper Rincon									
	Oxbow Restoration	Tipton Arroyo	Trujillo Arroyo	Montoya Arroyo	Holguin Arroyo	Green / Tierra Blanca Arroyos	Sibley Arroyo	Jaralosa Arroyo / Remnant Bosque	Yeso Arroyo	Crow Canyon / Channel Cut
PROJECT FUNCTIONALITY (USIBWC MISSION)	104.5	104	103	101.5	101	99.5	98	96.5	93.5	92
Raise levees/add flood control structures	-	-	-	-	-	-	-	-	-	-
Modify dredging at arroyos	-	0.018	0.018	0.018	-	0.037	0.018	-	0.037	-
Modify spoil disposal locations/practices	-	0.004	0.004	0.004	-	0.008	0.004	-	0.008	-
Acquire flood easements and set back levees	-	-	-	-	-	-	-	-	-	-
Reduce dredging of pilot channel	-	-	-	-	-	-	-	-	-	-
Reduce runoff entering river during floods	-	-	-	-	-	-	-	-	-	-
Erosion control/dams in tributaries	-	-	4.845	4.845	-	4.845	4.845	-	4.845	-
AQUATIC/RIPARIAN HABITAT ENHANCEMENTS										
Mouth of Arroyos/Canyons										
Retain/expand existing groin structures	-	-	-	-	-	-	-	-	-	-
Retain/expand existing weirs, embayments	-	-	-	-	-	-	-	-	-	-
Additional groin locations	0.003	0.003	-	-	0.003	0.006	-	0.006	-	0.006
Additional weir/embayment locations	0.052	0.052	-	0.105	0.105	0.105	0.105	0.157	0.105	0.105
Create/expand wetlands	0.099	0.099	0.197	0.197	0.197	0.197	0.197	0.493	0.197	0.197
Widen Channel	-	0.442	1.104	0.442	-	-	-	-	0.442	1.104
Water Diversion Structures & Siphons										
Create white-water fish habitat	-	-	-	-	-	-	-	-	-	-
Provide back-water habitat	-	-	-	-	-	-	-	-	-	-
Wasteways/Drains										
Reduced maintenance	-	-	-	-	-	-	-	0.083	0.042	-
Create embayments or enhance wetlands	-	-	-	0.361	-	-	-	0.361	0.181	-
Riparian Vegetation Sites										
Expand remnant bosques/riparian veg.	-	0.153	-	0.096	-	0.058	-	0.958	0.383	0.575
Control invasive vegetation (salt cedar)	0.129	0.114	0.414	0.328	0.086	0.343	0.300	0.857	1.228	1.499
Planting sites within ROW	-	-	0.269	0.134	0.537	0.537	0.269	0.537	-	0.537
Planting sites outside ROW	-	-	0.166	0.333	-	-	-	-	-	-
Land purchases for habitat	-	-	1.195	0.888	-	-	-	5.733	-	-
IBWC Land Management										
Retain existing no-mow zones	-	-	-	-	-	-	-	-	-	-
Additional no-mow zones	-	-	-	-	-	-	-	-	(0.807)	-
Discontinue leases	-	-	-	0.154	0.108	0.192	0.127	0.576	0.346	0.769
RESTORATION OF FLUVIAL PROCESSES										
Old Channels & Oxbows										
Channel splits in ROW	3.388	-	-	2.824	-	1.694	1.129	11.295	5.647	22.590
Embayments within ROW	-	-	-	-	0.021	-	-	-	0.021	-
Levee setback,	-	-	0.029	-	-	-	-	-	-	-
Control invasive vegetation (salt cedar) outside ROW	-	-	0.428	0.500	-	-	-	4.498	-	-
New meanders outside ROW	-	-	-	-	-	-	-	-	-	-
Bank overflow by shave downs	-	1.104	-	1.104	-	1.766	1.104	-	-	-
Create/expand wetlands outside ROW	-	-	-	2.290	-	-	-	4.580	-	-
Flow Regime Modification										
Allow seasonal peak flows	4.574	4.574	4.574	4.574	4.574	4.574	4.574	4.574	4.574	4.574
Establish minimum in-stream flows	-	-	-	-	-	-	-	-	-	-
MULTIPURPOSE PROJECT MANAGEMENT										
Add recreational areas	-	-	-	-	-	-	-	-	-	-
Interagency cooperation agreements	-	-	-	-	-	-	-	-	-	-
Improve water quality, water conservation	-	-	-	-	-	-	-	-	-	-
Total Alt. 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Alt. 2	$ -	$ 0.02	$ 0.02	$ 0.38	$ -	$ 0.04	$ 0.02	$ 0.44	$ 0.27	$ -
Alt. 3	$ 3.67	$ 0.44	$ 0.90	$ 4.22	$ 1.06	$ 3.18	$ 2.15	$ 15.33	$ 8.19	$ 26.28
Alt. 4	$ 3.67	$ 1.55	$ 2.72	$ 9.34	$ 1.06	$ 4.94	$ 3.25	$ 30.14	$ 8.19	$ 26.28
Alt. 5	$ 8.25	$ 6.12	$ 12.14	$ 18.75	$ 5.63	$ 14.36	$ 12.67	$ 34.71	$ 17.61	$ 30.85

	Lower Rincon								
	Hatch Siphon	Wetlands Unit A	Wetlands Unit B	Garfield Drain	Placitas Arroyo	Remnant Bosque / Rincon Siphon	Angostura Arroyo	Rincon / Reed Arroyos	Bignell Arroyo.
PROJECT FUNCTIONALITY (USIBWC MISSION)	90	89	87	86	84.5	83	80	78	76
Raise levees/add flood control structures	-	-	-	-	-	1.421	1.163	0.517	0.904
Modify dredging at arroyos	-	-	-	-	0.018	-	-	0.018	-
Modify spoil disposal locations/practices	-	-	-	-	0.004	-	-	0.004	-
Acquire flood easements and set back levees	-	-	-	-	-	3.411	0.814	-	-
Reduce dredging of pilot channel	-	-	-	-	-	-	-	-	-
Reduce runoff entering river during floods	-	-	-	-	-	-	-	-	-
Erosion control/dams in tributaries	-	-	-	-	4.845	-	-	9.689	4.845
AQUATIC/RIPARIAN HABITAT ENHANCEMENTS									
Mouth of Arroyos/Canyons									
Retain/expand existing groin structures	-	-	-	-	-	-	-	-	-
Retain/expand existing weirs, embayments	-	-	-	-	-	-	-	-	-
Additional groin locations	-	-	-	0.003	-	-	0.003	-	-
Additional weir/embayment locations	-	-	-	0.052	-	-	0.052	0.052	0.052
Create/expand wetlands	0.197	0.987	0.987	-	0.197	0.197	-	0.197	1.184
Widen Channel	-	-	-	-	-	-	-	-	-
Water Diversion Structures & Siphons									
Create white-water fish habitat	4.295	-	-	-	-	2.148	-	-	-
Provide back-water habitat	-	-	-	-	-	0.233	-	-	-
Wasteways/Drains									
Reduced maintenance	-	-	-	0.416	-	-	-	-	-
Create embayments or enhance wetlands	-	-	-	0.723	0.361	-	-	-	-
Riparian Vegetation Sites									
Expand remnant bosques/riparian veg.	0.077	-	-	0.096	0.192	0.192	0.192	0.096	0.096
Control invasive vegetation (salt cedar)	0.157	-	-	0.286	0.428	0.286	0.571	0.643	0.643
Planting sites within ROW	-	-	-	-	-	0.269	-	-	-
Planting sites outside ROW	-	-	-	-	0.333	0.333	0.166	-	-
Land purchases for habitat	-	-	-	-	2.132	1.760	0.694	-	-
IBWC Land Management									
Retain existing no-mow zones	-	-	-	-	-	-	-	-	-
Additional no-mow zones	(0.404)	-	-	(0.404)	(1.076)	(1.076)	(1.345)	(1.345)	(1.345)
Discontinue leases	-	-	-	-	-	-	-	-	-
RESTORATION OF FLUVIAL PROCESSES									
Old Channels & Oxbows									
Channel splits in ROW	-	-	-	-	-	-	-	-	-
Embayments within ROW	-	-	-	-	-	-	-	-	-
Levee setback,	-	-	-	-	-	-	-	-	-
Control invasive vegetation (salt cedar) outside ROW	-	-	-	-	1.599	1.271	0.471	-	-
New meanders outside ROW	-	-	-	-	-	-	-	-	-
Bank overflow by shave downs	-	-	-	-	-	-	-	-	-
Create/expand wetlands outside ROW	-	-	-	-	-	-	-	-	-
Flow Regime Modification									
Allow seasonal peak flows	-	-	-	-	-	-	-	-	-
Establish minimum in-stream flows	-	-	-	-	-	-	-	-	-
MULTIPURPOSE PROJECT MANAGEMENT									
Add recreational areas	-	-	-	-	-	-	-	-	-
Interagency cooperation agreements	-	-	-	-	-	-	-	-	-
Improve water quality, water conservation	-	-	-	-	-	-	-	-	-
Total Alt. 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Alt. 2	$ 4.30	$ -	$ -	$ 1.14	$ 0.38	$ 3.80	$ 1.16	$ 0.54	$ 0.90
Alt. 3	$ 4.73	$ 0.99	$ 0.99	$ 1.58	$ 1.20	$ 4.74	$ 1.98	$ 1.53	$ 2.88
Alt. 4	$ 4.73	$ 0.99	$ 0.99	$ 1.58	$ 5.26	$ 11.52	$ 4.13	$ 1.53	$ 2.88
Alt. 5	$ 4.73	$ 0.99	$ 0.99	$ 1.58	$ 10.11	$ 11.52	$ 4.13	$ 11.22	$ 7.72

	Seldon Canyon			Upper Mesilla				
	Dead Mans Curve	Broad Canyon	Leasburg Dam	Private Bosque	Levee Setback	Seldon Drain	Channel Cut	Wasteway No. 2A.
PROJECT FUNCTIONALITY (USIBWC MISSION)	69	67	62	57	56	55	54	52
Raise levees/add flood control structures	7.493	-	-	0.517	1.163	-	-	0.388
Modify dredging at arroyos	-	-	-	-	-	-	-	-
Modify spoil disposal locations/practices	-	-	-	-	-	-	-	-
Acquire flood easements and set back levees	-	-	-	-	-	-	-	-
Reduce dredging of pilot channel	(0.025)	(0.025)	(0.062)	-	-	-	-	-
Reduce runoff entering river during floods	-	-	-	-	-	-	-	-
Erosion control/dams in tributaries	-	4.845	-	-	-	-	-	-
AQUATIC/RIPARIAN HABITAT ENHANCEMENTS								
Mouth of Arroyos/Canyons								
Retain/expand existing groin structures	-	-	-	-	-	-	-	-
Retain/expand existing weirs, embayments	-	-	-	-	-	-	-	-
Additional groin locations	-	-	-	0.006	0.003	0.003	-	-
Additional weir/embayment locations	-	-	-	0.105	0.052	-	-	0.052
Create/expand wetlands	-	-	-	0.395	0.099	0.197	-	-
Widen Channel	-	-	-	-	-	-	-	-
Water Diversion Structures & Siphons								
Create white-water fish habitat	-	-	-	-	-	-	-	-
Provide back-water habitat	-	-	-	-	-	-	-	-
Wasteways/Drains								
Reduced maintenance	-	-	-	-	-	0.208	-	0.042
Create embayments or enhance wetlands	-	-	-	-	-	0.181	-	0.361
Riparian Vegetation Sites								
Expand remnant bosques/riparian veg.	-	-	-	1.150	-	-	0.383	-
Control invasive vegetation (salt cedar)	-	-	0.071	0.571	0.143	0.071	1.385	0.071
Planting sites within ROW	-	-	-	-	0.269	-	0.269	0.027
Planting sites outside ROW	0.083	0.166	-	-	-	-	-	-
Land purchases for habitat	0.953	0.759	-	-	0.404	-	-	-
IBWC Land Management								
Retain existing no-mow zones	-	-	-	-	-	-	-	-
Additional no-mow zones	-	-	-	-	-	-	-	(0.135)
Discontinue leases	-	-	-	0.384	0.077	-	0.576	-
RESTORATION OF FLUVIAL PROCESSES								
Old Channels & Oxbows								
Channel splits in ROW	-	-	-	-	-	-	12.989	-
Embayments within ROW	-	-	-	-	-	-	-	-
Levee setback,	-	-	-	-	-	-	-	-
Control invasive vegetation (salt cedar) outside ROW	0.486	0.528	-	-	0.286	-	-	-
New meanders outside ROW	-	-	-	-	2.985	-	-	-
Bank overflow by shave downs	-	-	-	-	-	-	2.208	-
Create/expand wetlands outside ROW	2.290	-	-	-	0.572	-	-	-
Flow Regime Modification								
Allow seasonal peak flows	-	-	-	-	-	-	-	-
Establish minimum in-stream flows	-	-	-	-	-	-	-	-
MULTIPURPOSE PROJECT MANAGEMENT								
Add recreational areas	-	-	0.715	-	-	-	-	-
Interagency cooperation agreements	-	-	-	-	-	-	-	-
Improve water quality, water conservation	-	-	-	-	-	-	-	-
Total Alt. 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Alt. 2	$ 7.47	$ (0.02)	$ (0.06)	$ 0.52	$ 1.16	$ 0.39	$ -	$ 0.79
Alt. 3	$ 7.47	$ (0.02)	$ 0.01	$ 3.13	$ 1.81	$ 0.66	$ 15.60	$ 0.94
Alt. 4	$ 11.28	$ 1.43	$ 0.01	$ 3.13	$ 6.05	$ 0.66	$ 17.81	$ 0.94
Alt. 5	$ 11.28	$ 6.27	$ 0.72	$ 3.13	$ 6.05	$ 0.66	$ 17.81	$ 0.94

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Table D.5 Life Cycle Costs ($ Million)

	Las Cruces				Lower Mesilla									El Paso								
	Wasteway No. 5	Wasteway No. 39	Wasteway No. 8	Wasteway No. 39A.	Clark Lateral	NMGF Bosque	Mesilla Dam	Pole Planting Area	Wasteway 18	Old Channel	Del Rio Drain	Wasteway 19	Wasteway 31 and Wasteway 20.	Jimenez & Three Saints West Drains.	East Drain / Border Steel.	Wasteway 34	Wasteway 35	Nemexas Drain	Sundland Park West Bank	Cottonwod Grove	Anapra Bridge	
PROJECT FUNCTIONALITY (USIBWC MISSION)	50	48.5	47.5	46.6	42.5	41.5	39.5	34	29.5	28	26.5	25.5	22	19.5	16	10	9	7	5	4	3	Total
Raise levees/add flood control structures	1.809	0.517	2.713	1.163	2.713	6.847	1.292	0.517	-	1.809	1.679	0.904	6.460	6.330	8.785	10.723	12.015	2.532	3.488	3.230	1.163	$ 90.3
Modify dredging at arroyos	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 0.2
Modify spoil disposal locations/practices	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 0.0
Acquire flood easements and set back levees	-	-	-	-	-	-	-	-	-	0.930	-	-	-	-	-	-	-	-	-	-	-	$ 5.2
Reduce dredging of pilot channel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ (0.1)
Reduce runoff entering river during floods	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Erosion control/dams in tributaries	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 48.4
AQUATIC/RIPARIAN HABITAT ENHANCEMENTS																						
Mouth of Arroyos/Canyons																						
Retain/expand existing groin structures	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Retain/expand existing weirs, embayments	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Additional groin locations	-	-	-	-	-	0.006	-	-	-	-	-	-	-	-	-	-	-	0.003	-	-	-	$ 0.1
Additional weir/embayment locations	0.052	0.052	0.105	0.052	-	0.105	-	0.052	-	-	-	-	-	0.105	-	0.052	0.052	0.052	-	-	-	$ 2.0
Create/expand wetlands	-	-	-	-	0.987	0.493	-	-	-	-	-	0.296	0.493	0.099	-	-	-	0.099	-	-	-	$ 9.2
Widen Channel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 3.5
Water Diversion Structures & Siphons																						
Create white-water fish habitat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 6.4
Provide back-water habitat	-	-	-	-	-	-	2.325	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 2.6
Wasteways/Drains																						
Reduced maintenance	0.042	0.042	0.624	-	-	1.665	-	-	0.208	-	-	0.333	0.208	0.208	0.083	-	0.208	0.167	1.832	-	-	$ 6.4
Create embayments or enhance wetlands	0.361	0.361	0.542	0.181	-	0.723	-	-	0.361	0.361	-	0.181	0.181	0.181	0.361	-	0.181	-	-	-	-	$ 6.5
Riparian Vegetation Sites																						
Expand remnant bosques/riparian veg.	-	-	-	-	-	-	-	0.019	-	-	-	-	-	-	-	-	-	-	-	0.058	-	$ 4.8
Control invasive vegetation (salt cedar)	0.129	0.157	0.200	0.086	0.214	0.571	-	0.057	0.143	0.157	0.214	0.114	0.071	0.500	0.057	-	0.186	0.343	0.771	0.428	0.143	$ 15.2
Planting sites within ROW	0.134	0.161	0.134	-	-	-	-	0.134	0.134	0.134	0.134	-	-	-	0.269	0.027	0.107	-	0.269	-	-	$ 5.3
Planting sites outside ROW	-	-	-	-	-	0.499	-	-	0.083	0.083	0.083	-	-	-	0.166	-	-	-	-	-	0.166	$ 2.7
Land purchases for habitat	-	-	-	0.258	-	1.841	-	-	0.388	0.581	0.565	-	-	-	0.404	-	-	-	-	-	0.549	$ 19.1
IBWC Land Management																						
Retain existing no-mow zones	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Additional no-mow zones	(0.296)	(0.350)	-	(0.135)	-	-	-	(0.269)	(0.269)	(0.430)	(0.538)	-	-	(0.269)	(0.323)	(0.027)	(0.323)	(0.538)	(0.538)	(0.888)	-	$ (13.1)
Discontinue leases	-	-	-	-	-	-	-	-	-	-	-	-	-	0.077	-	-	-	-	-	-	-	$ 3.4
RESTORATION OF FLUVIAL PROCESSES																						
Old Channels & Oxbows																						
Channel splits in ROW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 61.6
Embayments within ROW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 0.0
Levee setback,	-	-	-	-	-	0.039	-	-	0.031	0.039	0.019	-	-	-	-	-	-	-	-	-	-	$ 0.2
Control invasive vegetation (salt cedar) outside ROW	-	-	-	0.228	-	1.057	-	-	0.271	0.443	0.428	-	-	-	0.214	-	-	-	-	-	0.343	$ 13.1
New meanders outside ROW	-	-	-	-	-	11.941	-	-	4.776	4.776	3.582	-	-	-	-	-	-	-	-	-	-	$ 28.1
Bank overflow by shave downs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 7.3
Create/expand wetlands outside ROW	-	-	-	-	-	1.145	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 10.9
Flow Regime Modification																						
Allow seasonal peak flows	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 45.7
Establish minimum in-stream flows	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
MULTIPURPOSE PROJECT MANAGEMENT																						
Add recreational areas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.788	-	-	$ 2.5
Interagency cooperation agreements	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Improve water quality, water conservation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Total Alt. 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Alt. 2	$ 2.21	$ 0.92	$ 3.88	$ 1.34	$ 2.71	$ 9.24	$ 3.62	$ 0.52	$ 0.57	$ 2.17	$ 1.68	$ 1.42	$ 6.85	$ 6.72	$ 9.23	$ 10.72	$ 12.40	$ 2.70	$ 5.32	$ 3.23	$ 1.16	$ 112.3
Alt. 3	$ 2.53	$ 1.29	$ 4.32	$ 1.48	$ 3.91	$ 10.41	$ 3.62	$ 0.78	$ 0.85	$ 2.46	$ 2.03	$ 1.83	$ 7.41	$ 7.50	$ 9.56	$ 10.80	$ 12.75	$ 3.20	$ 6.36	$ 3.72	$ 1.31	$ 213.7
Alt. 4	$ 2.53	$ 1.29	$ 4.32	$ 1.97	$ 3.91	$ 26.93	$ 3.62	$ 0.78	$ 6.40	$ 9.31	$ 6.71	$ 1.83	$ 7.41	$ 7.50	$ 10.34	$ 10.80	$ 12.75	$ 3.20	$ 6.36	$ 3.72	$ 2.36	$ 300.1
Alt. 5	$ 2.53	$ 1.29	$ 4.32	$ 1.97	$ 3.91	$ 26.93	$ 3.62	$ 0.78	$ 6.40	$ 9.31	$ 6.71	$ 1.83	$ 7.41	$ 7.50	$ 10.34	$ 10.80	$ 12.75	$ 3.20	$ 8.15	$ 3.72	$ 2.36	$ 396.8

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Table D.4 Operation and Maintenance Annual Cost ($ Million / year)

	Upper Rincon										Lower Rincon									Seldon Canyon			Upper Mesilla				
	Oxbow Restoration	Tipton Arroyo	Trujillo Arroyo	Montoya Arroyo	Holguin Arroyo	Green / Tierra Blanca Arroyos	Sibley Arroyo	Jaralosa Arroyo / Remnant Bosque	Yeso Arroyo	Crow Canyon / Channel Cut	Hatch Siphon	Wetlands Unit A	Wetlands Unit B	Garfield Drain	Placitas Arroyo	Remnant Bosque / Rincon Siphon	Angostura Arroyo	Rincon / Reed Arroyos	Bignell Arroyo.	Dead Mans Curve	Broad Canyon	Leasburg Dam	Private Bosque	Levee Setback	Seldon Drain	Channel Cut	Wasteway No. 2A.
PROJECT FUNCTIONALITY (USIBWC MISSION)	104.5	104	103	101.5	101	99.5	98	96.5	93.5	92	90	89	87	86	84.5	83	80	78	76	69	67	62	57	56	55	54	52
Raise levees/add flood control structures	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.035	0.029	0.013	0.022	0.186	-	-	0.013	0.029	-	-	0.010
Modify dredging at arroyos	-	0.001	0.001	0.001	-	0.002	0.001	-	0.002	-	-	-	-	-	0.001	-	-	0.001	-	-	-	-	-	-	-	-	-
Modify spoil disposal locations/practices	-	0.000	0.000	0.000	-	0.000	0.000	-	0.000	-	-	-	-	-	0.000	-	-	0.000	-	-	-	-	-	-	-	-	-
Acquire flood easements and set back levees	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.084	0.020	-	-	-	-	-	-	-	-	-	-
Reduce dredging of pilot channel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(0.002)	(0.002)	(0.004)	-	-	-	-	-
Reduce runoff entering river during floods	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Erosion control/dams in tributaries	-	-	0.120	0.120	-	0.120	0.120	-	0.120	-	-	-	-	-	0.120	-	-	0.240	0.120	-	0.120	-	-	-	-	-	-
AQUATIC/RIPARIAN HABITAT ENHANCEMENTS																											
Mouth of Arroyos/Canyons																											
Retain/expand existing groin structures	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Retain/expand existing weirs, embayments	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Additional groin locations	0.000	0.000	-	-	0.000	0.000	-	0.000	-	0.000	-	-	-	0.000	-	-	0.000	-	-	-	-	-	0.000	0.000	0.000	-	-
Additional weir/embayment locations	0.001	0.001	-	0.003	0.003	0.003	0.003	0.004	0.003	0.003	-	-	-	0.001	-	-	0.001	0.001	0.001	-	-	-	0.003	0.001	-	-	0.001
Create/expand wetlands	0.003	0.003	0.006	0.006	0.006	0.006	0.006	0.016	0.006	0.006	0.006	0.032	0.032	-	0.006	0.006	-	0.006	0.039	-	-	-	0.013	0.003	0.006	-	-
Widen Channel	-	0.012	0.031	0.012	-	-	-	-	0.012	0.031	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water Diversion Structures & Siphons																											
Create white-water fish habitat	-	-	-	-	-	-	-	-	-	-	0.107	-	-	-	-	0.054	-	-	-	-	-	-	-	-	-	-	-
Provide back-water habitat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.006	-	-	-	-	-	-	-	-	-	-	-
Wasteways/Drains																											
Reduced maintenance	-	-	-	-	-	-	-	0.005	0.003	-	-	-	-	0.027	-	-	-	-	-	-	-	-	-	-	0.014	-	0.003
Create embayments or enhance wetlands	-	-	-	0.011	-	-	-	0.011	0.005	-	-	-	-	0.021	0.011	-	-	-	-	-	-	-	-	-	0.005	-	0.011
Riparian Vegetation Sites																											
Expand remnant bosques/riparian veg.	-	0.006	-	0.004	-	0.002	-	0.035	0.014	0.021	0.003	-	-	0.004	0.007	0.007	0.007	0.004	0.004	-	-	-	0.042	-	-	0.014	-
Control invasive vegetation (salt cedar)	0.004	0.003	0.012	0.010	0.002	0.010	0.009	0.025	0.036	0.044	0.005	-	-	0.008	0.012	0.008	0.017	0.019	0.019	-	-	0.002	0.017	0.004	0.002	0.040	0.002
Planting sites within ROW	-	-	0.012	0.006	0.024	0.024	0.012	0.024	-	0.024	-	-	-	-	-	0.012	-	-	-	-	-	-	-	0.012	-	0.012	0.001
Planting sites outside ROW	-	-	0.004	0.008	-	-	-	-	-	-	-	-	-	-	0.008	0.008	0.004	-	-	0.002	0.004	-	-	-	-	-	-
Land purchases for habitat	-	-	0.030	0.022	-	-	-	0.142	-	-	-	-	-	-	0.053	0.044	0.017	-	-	0.024	0.019	-	-	0.010	-	-	-
IBWC Land Management																											
Retain existing no-mow zones	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Additional no-mow zones	-	-	-	-	-	-	-	-	(0.053)	-	(0.026)	-	-	(0.026)	(0.070)	(0.070)	(0.088)	(0.088)	(0.088)	-	-	-	-	-	-	-	(0.009)
Discontinue leases	-	-	-	0.010	0.007	0.013	0.008	0.038	0.023	0.050	-	-	-	-	-	-	-	-	-	-	-	-	0.025	0.005	-	0.038	-
RESTORATION OF FLUVIAL PROCESSES																											
Old Channels & Oxbows																											
Channel splits in ROW	0.088	-	-	0.073	-	0.044	0.029	0.294	0.147	0.587	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.338	-
Embayments within ROW	-	-	-	-	0.001	-	-	-	0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Levee setback,	-	-	0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Control invasive vegetation (salt cedar) outside ROW	-	-	0.012	0.015	-	-	-	0.131	-	-	-	-	-	-	0.046	0.037	0.014	-	-	0.014	0.015	-	-	0.008	-	-	-
New meanders outside ROW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.077	-	-	-
Bank overflow by shave downs	-	0.031	-	0.031	-	0.049	0.031	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.062	-
Create/expand wetlands outside ROW	-	-	-	0.072	-	-	-	0.144	-	-	-	-	-	-	-	-	-	-	-	0.072	-	-	-	0.018	-	-	-
Flow Regime Modification																											
Allow seasonal peak flows	0.298	0.298	0.298	0.298	0.298	0.298	0.298	0.298	0.298	0.298	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Establish minimum in-stream flows	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MULTIPURPOSE PROJECT MANAGEMENT																											
Add recreational areas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.021	-	-	-	-	-
Interagency cooperation agreements	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Improve water quality, water conservation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total O&M Cost **Alt. 1**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Alt. 2	$ -	$ 0.00	$ 0.00	$ 0.01	$ -	$ 0.00	$ 0.00	$ 0.02	$ 0.01	$ -	$ 0.11	$ -	$ -	$ 0.05	$ 0.01	$ 0.09	$ 0.03	$ 0.01	$ 0.02	$ 0.18	$ (0.00)	$ (0.00)	$ 0.01	$ 0.03	$ 0.02	$ -	$ 0.02
Alt. 3	$ 0.10	$ 0.02	$ 0.03	$ 0.12	$ 0.04	$ 0.10	$ 0.07	$ 0.45	$ 0.24	$ 0.74	$ 0.12	$ 0.03	$ 0.03	$ 0.06	$ 0.04	$ 0.13	$ 0.05	$ 0.04	$ 0.08	$ 0.18	$ (0.00)	$ (0.00)	$ 0.11	$ 0.05	$ 0.03	$ 0.44	$ 0.03
Alt. 4	$ 0.10	$ 0.05	$ 0.08	$ 0.27	$ 0.04	$ 0.15	$ 0.10	$ 0.87	$ 0.24	$ 0.74	$ 0.12	$ 0.03	$ 0.03	$ 0.06	$ 0.15	$ 0.30	$ 0.11	$ 0.04	$ 0.08	$ 0.30	$ 0.04	$ (0.00)	$ 0.11	$ 0.17	$ 0.03	$ 0.50	$ 0.03
Alt. 5	$ 0.39	$ 0.34	$ 0.50	$ 0.69	$ 0.34	$ 0.57	$ 0.52	$ 1.17	$ 0.66	$ 1.03	$ 0.12	$ 0.03	$ 0.03	$ 0.06	$ 0.27	$ 0.30	$ 0.11	$ 0.28	$ 0.20	$ 0.30	$ 0.16	$ 0.02	$ 0.11	$ 0.17	$ 0.03	$ 0.50	$ 0.03

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Table D.4 Operation and Maintenance Annual Cost ($ Million / year)

	Las Cruces				Lower Mesilla									El Paso								
	Wasteway No. 5	Wasteway No. 39	Wasteway No. 8	Wasteway No. 39A.	Clark Lateral	NMGF Bosque	Mesilla Dam	Pole Planting Area	Wasteway 18	Old Channel	Del Rio Drain	Wasteway 19	Wasteway 31 and Wasteway 20.	Jimenez & Three Saints West Drains.	East Drain / Border Steel.	Wasteway 34	Wasteway 35	Nemexas Drain	Sundland Park West Bank	Cottonwod Grove	Anapra Bridge	
PROJECT FUNCTIONALITY (USIBWC MISSION)	50	48.5	47.5	46.6	42.5	41.5	39.5	34	29.5	28	26.5	25.5	22	19.5	16	10	9	7	5	4	3	Total
Raise levees/add flood control structures	0.045	0.013	0.067	0.029	0.067	0.170	0.032	0.013	-	0.045	0.042	0.022	0.160	0.157	0.218	0.266	0.298	0.063	0.086	0.080	0.029	$ 2.236
Modify dredging at arroyos	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 0.012
Modify spoil disposal locations/practices	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 0.002
Acquire flood easements and set back levees	-	-	-	-	-	-	-	-	-	0.023	-	-	-	-	-	-	-	-	-	-	-	$ 0.128
Reduce dredging of pilot channel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ (0.007)
Reduce runoff entering river during floods	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Erosion control/dams in tributaries	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 1.200
AQUATIC/RIPARIAN HABITAT ENHANCEMENTS																						
Mouth of Arroyos/Canyons																						
Retain/expand existing groin structures	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Retain/expand existing weirs, embayments	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Additional groin locations	-	-	-	-	-	0.000	-	-	-	-	-	-	-	-	-	-	-	0.000	-	-	-	$ 0.001
Additional weir/embayment locations	0.001	0.001	0.003	0.001	-	0.003	-	0.001	-	-	-	-	-	0.003	-	0.001	0.001	0.001	-	-	-	$ 0.049
Create/expand wetlands	-	-	-	-	0.032	0.016	-	-	-	-	-	0.010	0.016	0.003	-	-	-	0.003	-	-	-	$ 0.299
Widen Channel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 0.099
Water Diversion Structures & Siphons																						
Create white-water fish habitat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 0.161
Provide back-water habitat	-	-	-	-	-	-	0.058	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 0.063
Wasteways/Drains																						
Reduced maintenance	0.003	0.003	0.041	-	-	0.108	-	-	0.014	-	-	0.022	0.014	0.014	0.005	-	0.014	0.011	0.119	-	-	$ 0.417
Create embayments or enhance wetlands	0.011	0.011	0.016	0.005	-	0.021	-	-	0.011	0.011	-	0.005	0.005	0.005	0.011	-	0.005	-	-	-	-	$ 0.189
Riparian Vegetation Sites																						
Expand remnant bosques/riparian veg.	-	-	-	-	-	-	-	0.001	-	-	-	-	-	-	-	-	-	-	-	0.002	-	$ 0.176
Control invasive vegetation (salt cedar)	0.004	0.005	0.006	0.002	0.006	0.017	-	0.002	0.004	0.005	0.006	0.003	0.002	0.015	0.002	-	0.005	0.010	0.022	0.012	0.004	$ 0.441
Planting sites within ROW	0.006	0.007	0.006	-	-	-	-	0.006	0.006	0.006	0.006	-	-	-	0.012	0.001	0.005	-	0.012	-	-	$ 0.238
Planting sites outside ROW	-	-	-	-	-	0.012	-	-	0.002	0.002	0.002	-	-	-	0.004	-	-	-	-	-	0.004	$ 0.066
Land purchases for habitat	-	-	-	0.006	-	0.046	-	-	0.010	0.014	0.014	-	-	-	0.010	-	-	-	-	-	0.014	$ 0.473
IBWC Land Management																						
Retain existing no-mow zones	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Additional no-mow zones	(0.019)	(0.023)	-	(0.009)	-	-	-	(0.018)	(0.018)	(0.028)	(0.035)	-	-	(0.018)	(0.021)	(0.002)	(0.021)	(0.035)	(0.035)	(0.058)	-	$ (0.854)
Discontinue leases	-	-	-	-	-	-	-	-	-	-	-	-	-	0.005	-	-	-	-	-	-	-	$ 0.220
RESTORATION OF FLUVIAL PROCESSES																						
Old Channels & Oxbows																						
Channel splits in ROW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 1.601
Embayments within ROW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 0.001
Levee setback,	-	-	-	-	-	0.001	-	-	0.001	0.001	0.000	-	-	-	-	-	-	-	-	-	-	$ 0.004
Control invasive vegetation (salt cedar) outside ROW	-	-	-	0.007	-	0.031	-	-	0.008	0.013	0.012	-	-	-	0.006	-	-	-	-	-	0.010	$ 0.379
New meanders outside ROW	-	-	-	-	-	0.310	-	-	0.124	0.124	0.093	-	-	-	-	-	-	-	-	-	-	$ 0.728
Bank overflow by shave downs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 0.203
Create/expand wetlands outside ROW	-	-	-	-	-	0.036	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 0.343
Flow Regime Modification																						
Allow seasonal peak flows	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 2.975
Establish minimum in-stream flows	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
MULTIPURPOSE PROJECT MANAGEMENT																						
Add recreational areas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.051	-	-	$ 0.072
Interagency cooperation agreements	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Improve water quality, water conservation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Total O&M Cost Alt. 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Alt. 2	$ 0.06	$ 0.03	$ 0.12	$ 0.03	$ 0.07	$ 0.30	$ 0.09	$ 0.01	$ 0.02	$ 0.06	$ 0.04	$ 0.05	$ 0.18	$ 0.18	$ 0.23	$ 0.27	$ 0.32	$ 0.07	$ 0.21	$ 0.08	$ 0.03	$ 3.073
Alt. 3	$ 0.07	$ 0.04	$ 0.14	$ 0.04	$ 0.11	$ 0.33	$ 0.09	$ 0.02	$ 0.03	$ 0.07	$ 0.05	$ 0.06	$ 0.20	$ 0.20	$ 0.25	$ 0.27	$ 0.33	$ 0.09	$ 0.24	$ 0.09	$ 0.03	$ 6.099
Alt. 4	$ 0.07	$ 0.04	$ 0.14	$ 0.05	$ 0.11	$ 0.77	$ 0.09	$ 0.02	$ 0.18	$ 0.24	$ 0.18	$ 0.06	$ 0.20	$ 0.20	$ 0.27	$ 0.27	$ 0.33	$ 0.09	$ 0.24	$ 0.09	$ 0.06	$ 8.424
Alt. 5	$ 0.07	$ 0.04	$ 0.14	$ 0.05	$ 0.11	$ 0.77	$ 0.09	$ 0.02	$ 0.18	$ 0.24	$ 0.18	$ 0.06	$ 0.20	$ 0.20	$ 0.27	$ 0.27	$ 0.33	$ 0.09	$ 0.29	$ 0.09	$ 0.06	$ 12.671

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Table D.3 Capital Costs ($ Million)

Upper Rincon

	Oxbow Restoration	Tipton Arroyo	Trujillo Arroyo	Montoya Arroyo	Holguin Arroyo	Green / Tierra Blanca Arroyos	Sibley Arroyo	Jaralosa Arroyo / Remnant Bosque	Yeso Arroyo	Crow Canyon / Channel Cut
PROJECT FUNCTIONALITY (USIBWC MISSION)	104.5	104	103	101.5	101	99.5	98	96.5	93.5	92
Raise levees/add flood control structures	-	-	-	-	-	-	-	-	-	-
Modify dredging at arroyos	-	-	-	-	-	-	-	-	-	-
Modify spoil disposal locations/practices	-	-	-	-	-	-	-	-	-	-
Acquire flood easements and set back levees	-	-	-	-	-	-	-	-	-	-
Reduce dredging of pilot channel	-	-	-	-	-	-	-	-	-	-
Reduce runoff entering river during floods	-	-	-	-	-	-	-	-	-	-
Erosion control/dams in tributaries	-	-	3.000	3.000	-	3.000	3.000	-	3.000	-
AQUATIC/RIPARIAN HABITAT ENHANCEMENTS										
Mouth of Arroyos/Canyons										
Retain/expand existing groin structures	-	-	-	-	-	-	-	-	-	-
Retain/expand existing weirs, embayments	-	-	-	-	-	-	-	-	-	-
Additional groin locations	0.002	0.002	-	-	0.002	0.004	-	0.004	-	0.004
Additional weir/embayment locations	0.032	0.032	-	0.065	0.065	0.065	0.065	0.097	0.065	0.065
Create/expand wetlands	0.049	0.049	0.098	0.098	0.098	0.098	0.098	0.246	0.098	0.098
Widen Channel	-	0.252	0.630	0.252	-	-	-	-	0.252	0.630
Water Diversion Structures & Siphons										
Create white-water fish habitat	-	-	-	-	-	-	-	-	-	-
Provide back-water habitat	-	-	-	-	-	-	-	-	-	-
Wasteways/Drains										
Reduced maintenance	-	-	-	-	-	-	-	-	-	-
Create embayments or enhance wetlands	-	-	-	0.200	-	-	-	0.200	0.100	-
Riparian Vegetation Sites										
Expand remnant bosques/riparian veg.	-	0.066	-	0.042	-	0.025	-	0.415	0.166	0.249
Control invasive vegetation (salt cedar)	0.071	0.063	0.229	0.182	0.047	0.190	0.166	0.474	0.679	0.830
Planting sites within ROW	-	-	0.083	0.042	0.166	0.166	0.083	0.166	-	0.166
Planting sites outside ROW	-	-	0.103	0.206	-	-	-	-	-	-
Land purchases for habitat	-	-	0.740	0.550	-	-	-	3.550	-	-
IBWC Land Management										
Retain existing no-mow zones	-	-	-	-	-	-	-	-	-	-
Additional no-mow zones	-	-	-	-	-	-	-	-	-	-
Discontinue leases	-	-	-	-	-	-	-	-	-	-
RESTORATION OF FLUVIAL PROCESSES										
Old Channels & Oxbows										
Channel splits in ROW	2.03	-	-	1.70	-	1.02	0.68	6.78	3.39	13.56
Embayments within ROW	-	-	-	-	0.01	-	-	-	0.01	-
Levee setback,	-	-	0.02	-	-	-	-	-	-	-
Control invasive vegetation (salt cedar) outside ROW	-	-	0.24	0.28	-	-	-	2.49	-	-
New meanders outside ROW	-	-	-	-	-	-	-	-	-	-
Bank overflow by shave downs	-	0.63	-	0.63	-	1.01	0.63	-	-	-
Create/expand wetlands outside ROW	-	-	-	1.18	-	-	-	2.36	-	-
Flow Regime Modification										
Allow seasonal peak flows	-	-	-	-	-	-	-	-	-	-
Establish minimum in-stream flows	-	-	-	-	-	-	-	-	-	-
MULTIPURPOSE PROJECT MANAGEMENT										
Add recreational areas	-	-	-	-	-	-	-	-	-	-
Interagency cooperation agreements	-	-	-	-	-	-	-	-	-	-
Improve water quality, water conservation	-	-	-	-	-	-	-	-	-	-
Total Capital Cost Alt. 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Alt. 2	$ -	$ -	$ -	$ 0.20	$ -	$ -	$ -	$ 0.20	$ 0.10	$ -
Alt. 3	$ 2.19	$ 0.47	$ 1.04	$ 2.57	$ 0.39	$ 1.56	$ 1.09	$ 8.38	$ 4.76	$ 15.60
Alt. 4	$ 2.19	$ 1.10	$ 2.14	$ 5.42	$ 0.39	$ 2.57	$ 1.72	$ 16.78	$ 4.76	$ 15.60
Alt. 5	$ 2.19	$ 1.10	$ 5.14	$ 8.42	$ 0.39	$ 5.57	$ 4.72	$ 16.78	$ 7.76	$ 15.60

Lower Rincon

	Hatch Siphon	Wetlands Unit A	Wetlands Unit B	Garfield Drain	Placitas Arroyo	Remnant Bosque / Rincon Siphon	Angostura Arroyo	Rincon / Reed Arroyos	Bignell Arroyo.
PROJECT FUNCTIONALITY (USIBWC MISSION)	90	89	87	86	84.5	83	80	78	76
Raise levees/add flood control structures	-	-	-	-	-	0.880	0.720	0.320	0.560
Modify dredging at arroyos	-	-	-	-	-	-	-	-	-
Modify spoil disposal locations/practices	-	-	-	-	-	-	-	-	-
Acquire flood easements and set back levees	-	-	-	-	-	2.112	0.504	-	-
Reduce dredging of pilot channel	-	-	-	-	-	-	-	-	-
Reduce runoff entering river during floods	-	-	-	-	-	-	-	-	-
Erosion control/dams in tributaries	-	-	-	-	3.000	-	-	6.000	3.000
AQUATIC/RIPARIAN HABITAT ENHANCEMENTS									
Mouth of Arroyos/Canyons									
Retain/expand existing groin structures	-	-	-	-	-	-	-	-	-
Retain/expand existing weirs, embayments	-	-	-	-	-	-	-	-	-
Additional groin locations	-	-	-	0.002	-	-	0.002	-	-
Additional weir/embayment locations	-	-	-	0.032	-	-	0.032	0.032	0.032
Create/expand wetlands	0.098	0.492	0.492	-	0.098	0.098	-	0.098	0.590
Widen Channel	-	-	-	-	-	-	-	-	-
Water Diversion Structures & Siphons									
Create white-water fish habitat	2.648	-	-	-	-	1.324	-	-	-
Provide back-water habitat	-	-	-	-	-	0.144	-	-	-
Wasteways/Drains									
Reduced maintenance	-	-	-	-	-	-	-	-	-
Create embayments or enhance wetlands	-	-	-	0.400	0.200	-	-	-	-
Riparian Vegetation Sites									
Expand remnant bosques/riparian veg.	0.033	-	-	0.042	0.083	0.083	0.083	0.042	0.042
Control invasive vegetation (salt cedar)	0.087	-	-	0.158	0.237	0.158	0.316	0.356	0.356
Planting sites within ROW	-	-	-	-	-	0.083	-	-	-
Planting sites outside ROW	-	-	-	-	0.206	0.206	0.103	-	-
Land purchases for habitat	-	-	-	-	1.320	1.090	0.430	-	-
IBWC Land Management									
Retain existing no-mow zones	-	-	-	-	-	-	-	-	-
Additional no-mow zones	-	-	-	-	-	-	-	-	-
Discontinue leases	-	-	-	-	-	-	-	-	-
RESTORATION OF FLUVIAL PROCESSES									
Old Channels & Oxbows									
Channel splits in ROW	-	-	-	-	-	-	-	-	-
Embayments within ROW	-	-	-	-	-	-	-	-	-
Levee setback,	-	-	-	-	-	-	-	-	-
Control invasive vegetation (salt cedar) outside ROW	-	-	-	-	0.88	0.70	0.26	-	-
New meanders outside ROW	-	-	-	-	-	-	-	-	-
Bank overflow by shave downs	-	-	-	-	-	-	-	-	-
Create/expand wetlands outside ROW	-	-	-	-	-	-	-	-	-
Flow Regime Modification									
Allow seasonal peak flows	-	-	-	-	-	-	-	-	-
Establish minimum in-stream flows	-	-	-	-	-	-	-	-	-
MULTIPURPOSE PROJECT MANAGEMENT									
Add recreational areas	-	-	-	-	-	-	-	-	-
Interagency cooperation agreements	-	-	-	-	-	-	-	-	-
Improve water quality, water conservation	-	-	-	-	-	-	-	-	-
Total Capital Cost Alt. 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Alt. 2	$ 2.65	$ -	$ -	$ 0.40	$ 0.20	$ 2.35	$ 0.72	$ 0.32	$ 0.56
Alt. 3	$ 2.87	$ 0.49	$ 0.49	$ 0.63	$ 0.62	$ 2.77	$ 1.15	$ 0.85	$ 1.58
Alt. 4	$ 2.87	$ 0.49	$ 0.49	$ 0.63	$ 3.03	$ 6.88	$ 2.45	$ 0.85	$ 1.58
Alt. 5	$ 2.87	$ 0.49	$ 0.49	$ 0.63	$ 6.03	$ 6.88	$ 2.45	$ 6.85	$ 4.58

Seldon Canyon and **Upper Mesilla**

	Dead Mans Curve	Broad Canyon	Leasburg Dam	Private Bosque	Levee Setback	Seldon Drain	Channel Cut	Wasteway No. 2A.
	Seldon Canyon			**Upper Mesilla**				
PROJECT FUNCTIONALITY (USIBWC MISSION)	69	67	62	57	56	55	54	52
Raise levees/add flood control structures	4.640	-	-	0.320	0.720	-	-	0.240
Modify dredging at arroyos	-	-	-	-	-	-	-	-
Modify spoil disposal locations/practices	-	-	-	-	-	-	-	-
Acquire flood easements and set back levees	-	-	-	-	-	-	-	-
Reduce dredging of pilot channel	-	-	-	-	-	-	-	-
Reduce runoff entering river during floods	-	-	-	-	-	-	-	-
Erosion control/dams in tributaries	-	3.000	-	-	-	-	-	-
AQUATIC/RIPARIAN HABITAT ENHANCEMENTS								
Mouth of Arroyos/Canyons								
Retain/expand existing groin structures	-	-	-	-	-	-	-	-
Retain/expand existing weirs, embayments	-	-	-	-	-	-	-	-
Additional groin locations	-	-	-	0.004	0.002	0.002	-	-
Additional weir/embayment locations	-	-	-	0.065	0.032	-	-	0.032
Create/expand wetlands	-	-	-	0.197	0.049	0.098	-	-
Widen Channel	-	-	-	-	-	-	-	-
Water Diversion Structures & Siphons								
Create white-water fish habitat	-	-	-	-	-	-	-	-
Provide back-water habitat	-	-	-	-	-	-	-	-
Wasteways/Drains								
Reduced maintenance	-	-	-	-	-	-	-	-
Create embayments or enhance wetlands	-	-	-	-	-	0.100	-	0.200
Riparian Vegetation Sites								
Expand remnant bosques/riparian veg.	-	-	-	0.498	-	-	0.166	-
Control invasive vegetation (salt cedar)	-	-	0.040	0.316	0.079	0.040	0.766	0.040
Planting sites within ROW	-	-	-	-	0.083	-	0.083	0.008
Planting sites outside ROW	0.052	0.103	-	-	-	-	-	-
Land purchases for habitat	0.590	0.470	-	-	0.250	-	-	-
IBWC Land Management								
Retain existing no-mow zones	-	-	-	-	-	-	-	-
Additional no-mow zones	-	-	-	-	-	-	-	-
Discontinue leases	-	-	-	-	-	-	-	-
RESTORATION OF FLUVIAL PROCESSES								
Old Channels & Oxbows								
Channel splits in ROW	-	-	-	-	-	-	7.80	-
Embayments within ROW	-	-	-	-	-	-	-	-
Levee setback,	-	-	-	-	-	-	-	-
Control invasive vegetation (salt cedar) outside ROW	0.27	0.29	-	-	0.16	-	-	-
New meanders outside ROW	-	-	-	-	1.80	-	-	-
Bank overflow by shave downs	-	-	-	-	-	-	1.26	-
Create/expand wetlands outside ROW	1.18	-	-	-	0.30	-	-	-
Flow Regime Modification								
Allow seasonal peak flows	-	-	-	-	-	-	-	-
Establish minimum in-stream flows	-	-	-	-	-	-	-	-
MULTIPURPOSE PROJECT MANAGEMENT								
Add recreational areas	-	-	0.40	-	-	-	-	-
Interagency cooperation agreements	-	-	-	-	-	-	-	-
Improve water quality, water conservation	-	-	-	-	-	-	-	-
Total Capital Cost Alt. 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Alt. 2	$ 4.64	$ -	$ -	$ 0.32	$ 0.72	$ 0.10	$ -	$ 0.44
Alt. 3	$ 4.64	$ -	$ 0.04	$ 1.40	$ 0.97	$ 0.24	$ 8.81	$ 0.52
Alt. 4	$ 6.73	$ 0.87	$ 0.04	$ 1.40	$ 3.46	$ 0.24	$ 10.07	$ 0.52
Alt. 5	$ 6.73	$ 3.87	$ 0.44	$ 1.40	$ 3.46	$ 0.24	$ 10.07	$ 0.52

Table D.3 Capital Costs ($ Million)

	Las Cruces				Lower Mesilla									El Paso								
	Wasteway No. 5	Wasteway No. 39	Wasteway No. 8	Wasteway No. 39A.	Clark Lateral	NMGF Bosque	Mesilla Dam	Pole Planting Area	Wasteway 18	Old Channel	Del Rio Drain	Wasteway 19	Wasteway 31 and Wasteway 20.	Jimenez & Three Saints West Drains.	East Drain / Border Steel.	Wasteway 34	Wasteway 35	Newmexas Drain	Sundland Park West Bank	Cottonwod Grove	Anapra Bridge	
PROJECT FUNCTIONALITY (USIBWC MISSION)	50	48.5	47.5	46.6	42.5	41.5	39.5	34	29.5	28	26.5	25.5	22	19.5	16	10	9	7	5	4	3	Total
Raise levees/add flood control structures	1.120	0.320	1.680	0.720	1.680	4.240	0.800	0.320	-	1.120	1.040	0.560	4.000	3.920	5.440	6.640	7.440	1.568	2.160	2.000	0.720	$ 55.89
Modify dredging at arroyos	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Modify spoil disposal locations/practices	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Acquire flood easements and set back levees	-	-	-	-	-	-	-	-	-	0.576	-	-	-	-	-	-	-	-	-	-	-	$ 3.19
Reduce dredging of pilot channel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Reduce runoff entering river during floods	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Erosion control/dams in tributaries	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 30.00
AQUATIC/RIPARIAN HABITAT ENHANCEMENTS																						
Mouth of Arroyos/Canyons																						
Retain/expand existing groin structures	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Retain/expand existing weirs, embayments	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Additional groin locations	-	-	-	-	-	0.004	-	-	-	-	-	-	-	-	-	-	-	0.002	-	-	-	$ 0.04
Additional weir/embayment locations	0.032	0.032	0.065	0.032	-	0.065	-	0.032	-	-	-	-	-	0.065	-	0.032	0.032	0.032	-	-	-	$ 1.23
Create/expand wetlands	-	-	-	-	0.492	0.246	-	-	-	-	-	0.148	0.246	0.049	-	-	-	0.049	-	-	-	$ 4.58
Widen Channel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 2.02
Water Diversion Structures & Siphons																						
Create white-water fish habitat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 3.97
Provide back-water habitat	-	-	-	-	-	-	1.440	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 1.58
Wasteways/Drains																						
Reduced maintenance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Create embayments or enhance wetlands	0.200	0.200	0.300	0.100	-	0.400	-	-	0.200	0.200	-	0.100	0.100	0.100	0.200	-	0.100	-	-	-	-	$ 3.60
Riparian Vegetation Sites																						
Expand remnant bosques/riparian veg.	-	-	-	-	-	-	-	0.008	-	-	-	-	-	-	-	-	-	-	-	0.025	-	$ 2.07
Control invasive vegetation (salt cedar)	0.071	0.087	0.111	0.047	0.119	0.316	-	0.032	0.079	0.087	0.119	0.063	0.040	0.277	0.032	-	0.103	0.190	0.427	0.237	0.079	$ 8.39
Planting sites within ROW	0.042	0.050	0.042	-	-	-	-	0.042	0.042	0.042	0.042	-	-	-	0.083	0.008	0.033	-	0.083	-	-	$ 1.64
Planting sites outside ROW	-	-	-	-	-	0.309	-	-	0.052	0.052	0.052	-	-	-	0.103	-	-	-	-	-	0.103	$ 1.65
Land purchases for habitat	-	-	-	0.160	-	1.140	-	-	0.240	0.360	0.350	-	-	-	0.250	-	-	-	-	-	0.340	$ 11.83
IBWC Land Management																						
Retain existing no-mow zones	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Additional no-mow zones	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Discontinue leases	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
RESTORATION OF FLUVIAL PROCESSES																						
Old Channels & Oxbows																						
Channel splits in ROW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 36.95
Embayments within ROW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 0.03
Levee setback,	-	-	-	-	-	0.02	-	-	0.02	0.02	0.01	-	-	-	-	-	-	-	-	-	-	$ 0.10
Control invasive vegetation (salt cedar) outside ROW	-	-	-	0.13	-	0.58	-	-	0.15	0.24	0.24	-	-	-	0.12	-	-	-	-	-	0.19	$ 7.22
New meanders outside ROW	-	-	-	-	-	7.18	-	-	2.87	2.87	2.15	-	-	-	-	-	-	-	-	-	-	$ 16.87
Bank overflow by shave downs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 4.16
Create/expand wetlands outside ROW	-	-	-	-	-	0.59	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ 5.61
Flow Regime Modification																						
Allow seasonal peak flows	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Establish minimum in-stream flows	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
MULTIPURPOSE PROJECT MANAGEMENT																						
Add recreational areas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.00	-	-	$ 1.40
Interagency cooperation agreements	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Improve water quality, water conservation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$ -
Total Capital Cost Alt. 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Alt. 2	$ 1.32	$ 0.52	$ 1.98	$ 0.82	$ 1.68	$ 4.64	$ 2.24	$ 0.32	$ 0.20	$ 1.32	$ 1.04	$ 0.66	$ 4.10	$ 4.02	$ 5.64	$ 6.64	$ 7.54	$ 1.57	$ 2.16	$ 2.00	$ 0.72	$ 65.04
Alt. 3	$ 1.47	$ 0.69	$ 2.20	$ 0.90	$ 2.29	$ 5.27	$ 2.24	$ 0.43	$ 0.32	$ 1.45	$ 1.20	$ 0.87	$ 4.39	$ 4.41	$ 5.75	$ 6.68	$ 7.71	$ 1.84	$ 2.67	$ 2.26	$ 0.80	$ 121.97
Alt. 4	$ 1.47	$ 0.69	$ 2.20	$ 1.19	$ 2.29	$ 15.10	$ 2.24	$ 0.43	$ 3.65	$ 5.58	$ 4.00	$ 0.87	$ 4.39	$ 4.41	$ 6.23	$ 6.68	$ 7.71	$ 1.84	$ 2.67	$ 2.26	$ 1.43	$ 172.60
Alt. 5	$ 1.47	$ 0.69	$ 2.20	$ 1.19	$ 2.29	$ 15.10	$ 2.24	$ 0.43	$ 3.65	$ 5.58	$ 4.00	$ 0.87	$ 4.39	$ 4.41	$ 6.23	$ 6.68	$ 7.71	$ 1.84	$ 3.67	$ 2.26	$ 1.43	$ 204.00

J:\\RioGrande_alts1_mod6_3.xls\Captial Cost

Table D.2 Annual Water Use (Acre-feet / year)

	Upper Rincon										Lower Rincon									Seldon Canyon			Upper Mesilla				
	Oxbow Restoration	Tipton Arroyo	Trujillo Arroyo	Montoya Arroyo	Holguin Arroyo	Green / Tierra Blanca Arroyos	Sibley Arroyo	Jaralosa Arroyo / Remnant Bosque	Yeso Arroyo	Crow Canyon / Channel Cut	Hatch Siphon	Wetlands Unit A	Wetlands Unit B	Garfield Drain	Placitas Arroyo	Remnant Bosque / Rincon Siphon	Angostura Arroyo	Rincon / Reed Arroyos	Bignell Arroyo.	Dead Mans Curve	Broad Canyon	Leasburg Dam	Private Bosque	Levee Setback	Seldon Drain	Channel Cut	Wasteway No. 2A.
PROJECT FUNCTIONALITY (USIBWC MISSION)	104.5	104	103	101.5	101	99.5	98	96.5	93.5	92	90	89	87	86	84.5	83	78	76	69	67	62	57	56	55	54	52	50
Raise levees/add flood control structures	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Modify dredging at arroyos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Modify spoil disposal locations/practices	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acquire flood easements and set back levees	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reduce dredging of pilot channel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reduce runoff entering river during floods	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Erosion control/dams in tributaries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AQUATIC/RIPARIAN HABITAT ENHANCEMENTS																											
Mouth of Arroyos/Canyons																											
Retain/expand existing groin structures	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Retain/expand existing weirs, embayments	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional groin locations	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional weir/embayment locations	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Create/expand wetlands	5	5	10	10	10	10	10	25	10	10	10	50	50	0	10	10	0	10	60	0	0	0	20	5	10	0	0
Widen Channel	0	9	22.5	9	0	0	0	0	9	22.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Diversion Structures & Siphons																											
Create white-water fish habitat	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0
Provide back-water habitat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wasteways/Drains																											
Reduced maintenance	0	0	0	0	0	0	0	3	1.5	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	7.5	0	1.5
Create embayments or enhance wetlands	0	0	0	10	0	0	0	10	5	0	0	0	0	20	10	0	0	0	0	0	0	0	0	0	5	0	10
Riparian Vegetation Sites																											
Expand remnant bosques/riparian veg.	0	12	0	7.5	0	4.5	0	75	30	45	6	0	0	7.5	15	15	15	7.5	7.5	0	0	0	90	0	0	30	0
Control invasive vegetation (salt cedar)	-13.5	-12	-43.5	-34.5	-9	-36	-31.5	-90	-129	-157.5	-16.5	0	0	-30	-45	-30	-60	-67.5	-67.5	0	0	-7.5	-60	-15	-7.5	-145.5	-7.5
Planting sites within ROW	0	0	35	17.5	70	70	35	70	0	70	0	0	0	0	0	35	0	0	0	0	0	0	0	35	0	35	3.5
Planting sites outside ROW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Land purchases for habitat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IBWC Land Management																											
Retain existing no-mow zones	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional no-mow zones	0	0	0	0	0	0	0	0	30	0	15	0	0	15	40	40	50	50	50	0	0	0	0	0	0	0	5
Discontinue leases	0	0	0	40	28	50	33	150	90	200	0	0	0	0	0	0	0	0	0	0	0	0	100	20	0	150	0
RESTORATION OF FLUVIAL PROCESSES																											
Old Channels & Oxbows																											
Channel splits in ROW	27	0	0	22.5	0	13.5	9	90	45	180	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	103.5	0
Embayments within ROW	0	0	0	0	0.063	0	0	0	0.063	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Levee setback,	0	0	0.0003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Control invasive vegetation (salt cedar) outside ROW	0	0	-45	-52.5	0	0	0	-472.5	0	0	0	0	0	0	-168	-133.5	-49.5	0	0	-51	-55.5	0	0	-30	0	0	0
New meanders outside ROW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22.5	0	0	0
Bank overflow by shave downs	0	22.5	0	22.5	0	36	22.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45	0
Create/expand wetlands outside ROW	0	0	0	100	0	0	0	200	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	25	0	0	0
Flow Regime Modification																											
Allow seasonal peak flows	1190	1190	1190	1190	1190	1190	1190	1190	1190	1190	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Establish minimum in-stream flows	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MULTIPURPOSE PROJECT MANAGEMENT																											
Add recreational areas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0
Interagency cooperation agreements	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Improve water quality, water conservation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total (Acre Feet) – Alternative 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alternative 2	0	0	0	10	0	0	0	13	7	0	5	0	0	35	10	3	0	0	0	0	0	0	0	0	13	0	12
Alternative 3	19	5	2	73	99	112	56	333	53	348	5	50	50	13	-10	33	-45	-50	0	0	0	-8	150	45	15	173	8
Alternative 4	19	28	-43	143	99	148	78	61	53	348	5	50	50	13	-178	-101	-95	-50	0	49	-56	-8	150	63	15	218	8
Alternative 5	1209	1218	1147	1333	1289	1338	1268	1251	1243	1538	5	50	50	13	-178	-101	-95	-50	0	49	-56	11	150	63	15	218	8

J:\\RioGrande_alts1_mod6_3.xls\Annual Water Use

Table D.2 Annual Water Use (Acre-feet / year)

	Las Cruces				Lower Mesilla									El Paso								
	Wasteway No. 5	Wasteway No. 39	Wasteway No. 8	Wasteway No. 39A.	Clark Lateral	NMGF Bosque	Mesilla Dam	Pole Planting Area	Wasteway 18	Old Channel	Del Rio Drain	Wasteway 19	Wasteway 31 and Wasteway 20.	Jimenez & Three Saints West Drains.	East Drain / Border Steel.	Wasteway 34	Wasteway 35	Nemexas Drain	Sundland Park West Bank	Cottonwod Grove	Anapra Bridge	
PROJECT FUNCTIONALITY (USIBWC MISSION)	50	48.5	47.5	46.6	42.5	41.5	39.5	34	29.5	28	26.5	25.5	22	19.5	16	10	9	7	5	4	3	Total
Raise levees/add flood control structures	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Modify dredging at arroyos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Modify spoil disposal locations/practices	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acquire flood easements and set back levees	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reduce dredging of pilot channel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reduce runoff entering river during floods	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Erosion control/dams in tributaries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AQUATIC/RIPARIAN HABITAT ENHANCEMENTS																						
Mouth of Arroyos/Canyons																						
Retain/expand existing groin structures	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Retain/expand existing weirs, embayments	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional groin locations	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional weir/embayment locations	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Create/expand wetlands	0	0	0	0	50	25	0	0	0	0	0	15	25	5	0	0	0	5	0	0	0	465
Widen Channel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	72
Water Diversion Structures & Siphons																						
Create white-water fish habitat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7.5
Provide back-water habitat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wasteways/Drains																						
Reduced maintenance	1.5	1.5	22.5	0	0	60	0	0	7.5	0	0	12	7.5	7.5	3	0	7.5	6	66	0	0	231
Create embayments or enhance wetlands	10	10	15	5	0	20	0	0	10	10	0	5	5	5	10	0	5	0	0	0	0	180
Riparian Vegetation Sites																						
Expand remnant bosques/riparian veg.	0	0	0	0	0	0	0	1.5	0	0	0	0	0	0	0	0	0	0	0	4.5	0	374
Control invasive vegetation (salt cedar)	-13.5	-16.5	-21	-9	-22.5	-60	0	-6	-15	-16.5	-22.5	-12	-7.5	-52.5	-6	0	-19.5	-36	-81	-45	-15	-1593
Planting sites within ROW	17.5	21	17.5	0	0	0	0	17.5	17.5	17.5	17.5	0	0	0	35	3.5	14	0	35	0	0	690
Planting sites outside ROW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Land purchases for habitat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IBWC Land Management																						
Retain existing no-mow zones	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Additional no-mow zones	11	13	0	5	0	0	0	10	10	16	20	0	0	10	12	1	12	20	20	33	0	488
Discontinue leases	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	881
RESTORATION OF FLUVIAL PROCESSES																						
Old Channels & Oxbows																						
Channel splits in ROW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	491
Embayments within ROW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
Levee setback,	0	0	0	0	0	0.0004	0	0	0.0003	0.0004	0.0002	0	0	0	0	0	0	0	0	0	0	0.002
Control invasive vegetation (salt cedar) outside ROW	0	0	0	-24	0	-111	0	0	-28.5	-46.5	-45	0	0	0	-22.5	0	0	0	0	0	-36	-1371
New meanders outside ROW	0	0	0	0	0	90	0	0	36	36	27	0	0	0	0	0	0	0	0	0	0	212
Bank overflow by shave downs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	149
Create/expand wetlands outside ROW	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	475
Flow Regime Modification																						
Allow seasonal peak flows	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11901
Establish minimum in-stream flows	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MULTIPURPOSE PROJECT MANAGEMENT																						
Add recreational areas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45	0	0	63
Interagency cooperation agreements	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Improve water quality, water conservation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total (Acre Feet) — **Alternative 1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
Alternative 2	12	12	38	5	0	80	0	0	18	10	0	17	13	13	13	0	13	6	66	0	0	419
Alternative 3	16	16	34	-4	28	45	0	13	20	11	-5	20	30	-15	42	4	7	-25	20	-41	-15	1,725
Alternative 4	16	16	34	-28	28	74	0	13	28	1	-23	20	30	-15	20	4	7	-25	20	-41	-51	1,189
Alternative 5	16	16	34	-28	28	74	0	13	28	1	-23	20	30	-15	20	4	7	-25	65	-41	-51	13,153

Table D.6 Summary of Costs ($ Million)

Upper Rincon

		Oxbow Restoration	Tipton Arroyo	Trujillo Arroyo	Montoya Arroyo	Holguin Arroyo	Green / Tierra Blanca Arroyos	Sibley Arroyo	Jaralosa Arroyo / Remnant Bosque	Yeso Arroyo	Crow Canyon / Channel Cut
		104.5	104	103	101.5	101	99.5	98	96.5	93.5	92
Non-Water Supply Life Cycle Cost	Alternative 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Alternative 2	$ -	$ 0.02	$ 0.02	$ 0.15	$ -	$ 0.04	$ 0.02	$ 0.19	$ 0.14	$ -
	Alternative 3	$ 1.41	$ 0.21	$ 0.49	$ 1.62	$ 0.28	$ 1.18	$ 0.85	$ 5.66	$ 3.48	$ 9.97
	Alternative 4	$ 1.41	$ 0.60	$ 1.38	$ 3.62	$ 0.28	$ 1.80	$ 1.23	$ 13.12	$ 3.48	$ 9.97
	Alternative 5	$ 1.41	$ 0.60	$ 3.22	$ 5.47	$ 0.28	$ 3.65	$ 3.08	$ 13.12	$ 5.33	$ 9.97
Water Supply Life Cycle Cost	Alternative 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Alternative 2	$ -	$ -	$ -	$ 0.04	$ -	$ -	$ -	$ 0.05	$ 0.02	$ -
	Alternative 3	$ 0.07	$ 0.02	$ 0.01	$ 0.28	$ 0.38	$ 0.43	$ 0.21	$ 1.28	$ 0.20	$ 1.34
	Alternative 4	$ 0.07	$ 0.11	$ (0.17)	$ 0.55	$ 0.38	$ 0.57	$ 0.30	$ 0.23	$ 0.20	$ 1.34
	Alternative 5	$ 4.64	$ 4.68	$ 4.41	$ 5.12	$ 4.95	$ 5.14	$ 4.87	$ 4.81	$ 4.78	$ 5.91
Non-Flood Control Capital Life Cyle Costs	Alternative 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Alternative 2	$ -	$ -	$ -	$ 0.20	$ -	$ -	$ -	$ 0.20	$ 0.10	$ -
	Alternative 3	$ 2.19	$ 0.47	$ 1.04	$ 2.57	$ 0.39	$ 1.56	$ 1.09	$ 8.38	$ 4.76	$ 15.60
	Alternative 4	$ 2.19	$ 1.10	$ 2.12	$ 5.42	$ 0.39	$ 2.57	$ 1.72	$ 16.78	$ 4.76	$ 15.60
	Alternative 5	$ 2.19	$ 1.10	$ 5.12	$ 8.42	$ 0.39	$ 5.57	$ 4.72	$ 16.78	$ 7.76	$ 15.60
Flood Control Capital Life Cyle Costs	Alternative 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Alternative 2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Alternative 3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Alternative 4	$ -	$ -	$ 0.02	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Alternative 5	$ -	$ -	$ 0.02	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Life Cycle Cost	Alternative 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Alternative 2	$ -	$ 0.02	$ 0.02	$ 0.38	$ -	$ 0.04	$ 0.02	$ 0.44	$ 0.27	$ -
	Alternative 3	$ 3.67	$ 0.44	$ 0.90	$ 4.22	$ 1.06	$ 3.18	$ 2.15	$ 15.33	$ 8.19	$ 26.28
	Alternative 4	$ 3.67	$ 1.55	$ 2.72	$ 9.34	$ 1.06	$ 4.94	$ 3.25	$ 30.14	$ 8.19	$ 26.28
	Alternative 5	$ 8.25	$ 6.12	$ 12.14	$ 18.75	$ 5.63	$ 14.36	$ 12.67	$ 34.71	$ 17.61	$ 30.85

Lower Rincon

		Hatch Siphon	Wetlands Unit A	Wetlands Unit B	Garfield Drain	Placitas Arroyo	Remnant Bosque / Rincon Siphon	Angostura Arroyo	Rincon / Reed Arroyos	Bignell Arroyo.
		90	89	87	86	84.5	83	80	78	76
Non-Water Supply Life Cycle Cost	Alternative 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Alternative 2	$ 1.63	$ -	$ -	$ 0.60	$ 0.15	$ 1.44	$ 0.44	$ 0.22	$ 0.34
	Alternative 3	$ 1.84	$ 0.30	$ 0.30	$ 0.89	$ 0.62	$ 1.85	$ 1.00	$ 0.87	$ 1.30
	Alternative 4	$ 1.84	$ 0.30	$ 0.30	$ 0.89	$ 2.92	$ 5.03	$ 2.04	$ 0.87	$ 1.30
	Alternative 5	$ 1.84	$ 0.30	$ 0.30	$ 0.89	$ 4.76	$ 5.03	$ 2.04	$ 4.56	$ 3.14
Water Supply Life Cycle Cost	Alternative 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Alternative 2	$ 0.02	$ -	$ -	$ 0.13	$ 0.04	$ 0.01	$ -	$ -	$ -
	Alternative 3	$ 0.02	$ 0.19	$ 0.19	$ 0.05	$ (0.04)	$ 0.12	$ (0.17)	$ (0.19)	$ -
	Alternative 4	$ 0.02	$ 0.19	$ 0.19	$ 0.05	$ (0.68)	$ (0.39)	$ (0.36)	$ (0.19)	$ -
	Alternative 5	$ 0.02	$ 0.19	$ 0.19	$ 0.05	$ (0.68)	$ (0.39)	$ (0.36)	$ (0.19)	$ -
Non-Flood Control Capital Life Cyle Costs	Alternative 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Alternative 2	$ 2.65	$ -	$ -	$ 0.40	$ 0.20	$ 1.47	$ -	$ -	$ -
	Alternative 3	$ 2.87	$ 0.49	$ 0.49	$ 0.63	$ 0.62	$ 1.89	$ 0.43	$ 0.53	$ 1.02
	Alternative 4	$ 2.87	$ 0.49	$ 0.49	$ 0.63	$ 3.03	$ 3.89	$ 1.23	$ 0.53	$ 1.02
	Alternative 5	$ 2.87	$ 0.49	$ 0.49	$ 0.63	$ 6.03	$ 3.89	$ 1.23	$ 6.53	$ 4.02
Flood Control Capital Life Cyle Costs	Alternative 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Alternative 2	$ -	$ -	$ -	$ -	$ -	$ 0.88	$ 0.72	$ 0.32	$ 0.56
	Alternative 3	$ -	$ -	$ -	$ -	$ -	$ 0.88	$ 0.72	$ 0.32	$ 0.56
	Alternative 4	$ -	$ -	$ -	$ -	$ -	$ 2.99	$ 1.22	$ 0.32	$ 0.56
	Alternative 5	$ -	$ -	$ -	$ -	$ -	$ 2.99	$ 1.22	$ 0.32	$ 0.56
Total Life Cycle Cost	Alternative 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Alternative 2	$ 4.30	$ -	$ -	$ 1.14	$ 0.38	$ 3.80	$ 1.16	$ 0.54	$ 0.90
	Alternative 3	$ 4.73	$ 0.99	$ 0.99	$ 1.58	$ 1.20	$ 4.74	$ 1.98	$ 1.53	$ 2.88
	Alternative 4	$ 4.73	$ 0.99	$ 0.99	$ 1.58	$ 5.26	$ 11.52	$ 4.13	$ 1.53	$ 2.88
	Alternative 5	$ 4.73	$ 0.99	$ 0.99	$ 1.58	$ 10.11	$ 11.52	$ 4.13	$ 11.22	$ 7.72

Seldon Canyon

		Dead Mans Curve	Broad Canyon	Leasburg Dam
		69	67	62
Non-Water Supply Life Cycle Cost	Alternative 1	$ -	$ -	$ -
	Alternative 2	$ 2.83	$ (0.02)	$ (0.06)
	Alternative 3	$ 2.83	$ (0.02)	$ (0.00)
	Alternative 4	$ 4.36	$ 0.78	$ (0.00)
	Alternative 5	$ 4.36	$ 2.62	$ 0.24
Water Supply Life Cycle Cost	Alternative 1	$ -	$ -	$ -
	Alternative 2	$ -	$ -	$ -
	Alternative 3	$ -	$ -	$ (0.03)
	Alternative 4	$ 0.19	$ (0.21)	$ (0.03)
	Alternative 5	$ 0.19	$ (0.21)	$ 0.04
Non-Flood Control Capital Life Cyle Costs	Alternative 1	$ -	$ -	$ -
	Alternative 2	$ -	$ -	$ -
	Alternative 3	$ -	$ -	$ 0.04
	Alternative 4	$ 2.09	$ 0.87	$ 0.04
	Alternative 5	$ 2.09	$ 3.87	$ 0.44
Flood Control Capital Life Cyle Costs	Alternative 1	$ -	$ -	$ -
	Alternative 2	$ 4.64	$ -	$ -
	Alternative 3	$ 4.64	$ -	$ -
	Alternative 4	$ 4.64	$ -	$ -
	Alternative 5	$ 4.64	$ -	$ -
Total Life Cycle Cost	Alternative 1	$ -	$ -	$ -
	Alternative 2	$ 7.47	$ (0.02)	$ (0.06)
	Alternative 3	$ 7.47	$ (0.02)	$ 0.01
	Alternative 4	$ 11.28	$ 1.43	$ 0.01
	Alternative 5	$ 11.28	$ 6.27	$ 0.72

Upper Mesilla

		Private Bosque	Levee Setback	Seldon Drain	Channel Cut	Wasteway No. 2A.
		57	56	55	54	52
Non-Water Supply Life Cycle Cost	Alternative 1	$ -	$ -	$ -	$ -	$ -
	Alternative 2	$ 0.20	$ 0.44	$ 0.24	$ -	$ 0.31
	Alternative 3	$ 1.15	$ 0.67	$ 0.36	$ 6.13	$ 0.39
	Alternative 4	$ 1.15	$ 2.35	$ 0.36	$ 6.90	$ 0.39
	Alternative 5	$ 1.15	$ 2.35	$ 0.36	$ 6.90	$ 0.39
Water Supply Life Cycle Cost	Alternative 1	$ -	$ -	$ -	$ -	$ -
	Alternative 2	$ -	$ -	$ 0.05	$ -	$ 0.04
	Alternative 3	$ 0.58	$ 0.17	$ 0.06	$ 0.66	$ 0.03
	Alternative 4	$ 0.58	$ 0.24	$ 0.06	$ 0.84	$ 0.03
	Alternative 5	$ 0.58	$ 0.24	$ 0.06	$ 0.84	$ 0.03
Non-Flood Control Capital Life Cyle Costs	Alternative 1	$ -	$ -	$ -	$ -	$ -
	Alternative 2	$ -	$ -	$ 0.10	$ -	$ 0.20
	Alternative 3	$ 1.08	$ 0.25	$ 0.24	$ 8.81	$ 0.28
	Alternative 4	$ 1.08	$ 2.74	$ 0.24	$ 10.07	$ 0.28
	Alternative 5	$ 1.08	$ 2.74	$ 0.24	$ 10.07	$ 0.28
Flood Control Capital Life Cyle Costs	Alternative 1	$ -	$ -	$ -	$ -	$ -
	Alternative 2	$ 0.32	$ 0.72	$ -	$ -	$ 0.24
	Alternative 3	$ 0.32	$ 0.72	$ -	$ -	$ 0.24
	Alternative 4	$ 0.32	$ 0.72	$ -	$ -	$ 0.24
	Alternative 5	$ 0.32	$ 0.72	$ -	$ -	$ 0.24
Total Life Cycle Cost	Alternative 1	$ -	$ -	$ -	$ -	$ -
	Alternative 2	$ 0.52	$ 1.16	$ 0.39	$ -	$ 0.79
	Alternative 3	$ 3.13	$ 1.81	$ 0.66	$ 15.60	$ 0.94
	Alternative 4	$ 3.13	$ 6.05	$ 0.66	$ 17.81	$ 0.94
	Alternative 5	$ 3.13	$ 6.05	$ 0.66	$ 17.81	$ 0.94

Table D.6 Summary of Costs ($ Million)

		Las Cruces				Lower Mesilla									El Paso								
		Wasteway No. 5	Wasteway No. 39	Wasteway No. 8	Wasteway No. 39A.	Clark Lateral	NMGF Bosque	Mesilla Dam	Pole Planting Area	Wasteway 18	Old Channel	Del Rio Drain	Wasteway 19	Wasteway 31 and Wasteway 20.	Jimenez & Three Saints West Drains.	East Drain / Border Steel.	Wasteway 34	Wasteway 35	Nemexas Drain	Sundland Park West Bank	Cottonwod Grove	Anapra Bridge	
		50	48.5	47.5	46.6	42.5	41.5	39.5	34	29.5	28	26.5	25.5	22	19.5	16	10	9	7	5	4	3	Total
Non-Water Supply Life Cycle Cost	Alternative 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Alternative 2	$ 0.85	$ 0.36	$ 1.76	$ 0.50	$ 1.03	$ 4.29	$ 1.38	$ 0.20	$ 0.30	$ 0.81	$ 0.64	$ 0.69	$ 2.70	$ 2.65	$ 3.54	$ 4.08	$ 4.82	$ 1.11	$ 2.91	$ 1.23	$ 0.44	$ 45.6
	Alternative 3	$ 1.00	$ 0.54	$ 1.99	$ 0.60	$ 1.52	$ 4.97	$ 1.38	$ 0.30	$ 0.45	$ 0.97	$ 0.85	$ 0.88	$ 2.91	$ 3.15	$ 3.64	$ 4.11	$ 5.01	$ 1.45	$ 3.61	$ 1.61	$ 0.56	$ 87.1
	Alternative 4	$ 1.00	$ 0.54	$ 1.99	$ 0.89	$ 1.52	$ 11.55	$ 1.38	$ 0.30	$ 2.64	$ 3.74	$ 2.79	$ 0.88	$ 2.91	$ 3.15	$ 4.04	$ 4.11	$ 5.01	$ 1.45	$ 3.61	$ 1.61	$ 1.13	$ 124.9
	Alternative 5	$ 1.00	$ 0.54	$ 1.99	$ 0.89	$ 1.52	$ 11.55	$ 1.38	$ 0.30	$ 2.64	$ 3.74	$ 2.79	$ 0.88	$ 2.91	$ 3.15	$ 4.04	$ 4.11	$ 5.01	$ 1.45	$ 4.23	$ 1.61	$ 1.13	$ 144.2
Water Supply Life Cycle Cost	Alternative 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Alternative 2	$ 0.04	$ 0.04	$ 0.14	$ 0.02	$ -	$ 0.31	$ -	$ -	$ 0.07	$ 0.04	$ -	$ 0.07	$ 0.05	$ 0.05	$ 0.05	$ -	$ 0.05	$ 0.02	$ 0.25	$ -	$ -	$ 1.6
	Alternative 3	$ 0.06	$ 0.06	$ 0.13	$ (0.02)	$ 0.11	$ 0.17	$ -	$ 0.05	$ 0.08	$ 0.04	$ (0.02)	$ 0.08	$ 0.12	$ (0.06)	$ 0.16	$ 0.01	$ 0.03	$ (0.10)	$ 0.08	$ (0.16)	$ (0.06)	$ 6.6
	Alternative 4	$ 0.06	$ 0.06	$ 0.13	$ (0.11)	$ 0.11	$ 0.28	$ -	$ 0.05	$ 0.11	$ 0.00	$ (0.09)	$ 0.08	$ 0.12	$ (0.06)	$ 0.07	$ 0.01	$ 0.03	$ (0.10)	$ 0.08	$ (0.16)	$ (0.20)	$ 4.6
	Alternative 5	$ 0.06	$ 0.06	$ 0.13	$ (0.11)	$ 0.11	$ 0.28	$ -	$ 0.05	$ 0.11	$ 0.00	$ (0.09)	$ 0.08	$ 0.12	$ (0.06)	$ 0.07	$ 0.01	$ 0.03	$ (0.10)	$ 0.25	$ (0.16)	$ (0.20)	$ 50.5
Non-Flood Control Capital Life Cyle Costs	Alternative 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Alternative 2	$ 0.20	$ 0.20	$ 0.30	$ 0.10	$ -	$ 0.40	$ 1.44	$ -	$ 0.20	$ 0.20	$ -	$ 0.10	$ 0.10	$ 0.10	$ 0.20	$ -	$ 0.10	$ -	$ -	$ -	$ -	$ 9.2
	Alternative 3	$ 0.35	$ 0.37	$ 0.52	$ 0.18	$ 0.61	$ 1.03	$ 1.44	$ 0.11	$ 0.32	$ 0.33	$ 0.16	$ 0.31	$ 0.39	$ 0.49	$ 0.31	$ 0.04	$ 0.27	$ 0.27	$ 0.51	$ 0.26	$ 0.08	$ 66.1
	Alternative 4	$ 0.35	$ 0.37	$ 0.52	$ 0.47	$ 0.61	$ 10.83	$ 1.44	$ 0.11	$ 3.63	$ 3.86	$ 2.95	$ 0.31	$ 0.39	$ 0.49	$ 0.79	$ 0.04	$ 0.27	$ 0.27	$ 0.51	$ 0.26	$ 0.71	$ 113.4
	Alternative 5	$ 0.35	$ 0.37	$ 0.52	$ 0.47	$ 0.61	$ 10.83	$ 1.44	$ 0.11	$ 3.63	$ 3.86	$ 2.95	$ 0.31	$ 0.39	$ 0.49	$ 0.79	$ 0.04	$ 0.27	$ 0.27	$ 1.51	$ 0.26	$ 0.71	$ 144.8
Flood Control Capital Life Cyle Costs	Alternative 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Alternative 2	$ 1.12	$ 0.32	$ 1.68	$ 0.72	$ 1.68	$ 4.24	$ 0.80	$ 0.32	$ -	$ 1.12	$ 1.04	$ 0.56	$ 4.00	$ 3.92	$ 5.44	$ 6.64	$ 7.44	$ 1.57	$ 2.16	$ 2.00	$ 0.72	$ 55.9
	Alternative 3	$ 1.12	$ 0.32	$ 1.68	$ 0.72	$ 1.68	$ 4.24	$ 0.80	$ 0.32	$ -	$ 1.12	$ 1.04	$ 0.56	$ 4.00	$ 3.92	$ 5.44	$ 6.64	$ 7.44	$ 1.57	$ 2.16	$ 2.00	$ 0.72	$ 55.9
	Alternative 4	$ 1.12	$ 0.32	$ 1.68	$ 0.72	$ 1.68	$ 4.26	$ 0.80	$ 0.32	$ 0.02	$ 1.72	$ 1.05	$ 0.56	$ 4.00	$ 3.92	$ 5.44	$ 6.64	$ 7.44	$ 1.57	$ 2.16	$ 2.00	$ 0.72	$ 59.2
	Alternative 5	$ 1.12	$ 0.32	$ 1.68	$ 0.72	$ 1.68	$ 4.26	$ 0.80	$ 0.32	$ 0.02	$ 1.72	$ 1.05	$ 0.56	$ 4.00	$ 3.92	$ 5.44	$ 6.64	$ 7.44	$ 1.57	$ 2.16	$ 2.00	$ 0.72	$ 59.2
Total Life Cycle Cost	Alternative 1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Alternative 2	$ 2.21	$ 0.92	$ 3.88	$ 1.34	$ 2.71	$ 9.24	$ 3.62	$ 0.52	$ 0.57	$ 2.17	$ 1.68	$ 1.42	$ 6.85	$ 6.72	$ 9.23	$ 10.72	$ 12.40	$ 2.70	$ 5.32	$ 3.23	$ 1.16	$ 112.3
	Alternative 3	$ 2.53	$ 1.29	$ 4.32	$ 1.48	$ 3.91	$ 10.41	$ 3.62	$ 0.78	$ 0.85	$ 2.46	$ 2.03	$ 1.83	$ 7.41	$ 7.50	$ 9.56	$ 10.80	$ 12.75	$ 3.20	$ 6.36	$ 3.72	$ 1.31	$ 213.7
	Alternative 4	$ 2.53	$ 1.29	$ 4.32	$ 1.97	$ 3.91	$ 26.93	$ 3.62	$ 0.78	$ 6.40	$ 9.31	$ 6.71	$ 1.83	$ 7.41	$ 7.50	$ 10.34	$ 10.80	$ 12.75	$ 3.20	$ 6.36	$ 3.72	$ 2.36	$ 300.1
	Alternative 5	$ 2.53	$ 1.29	$ 4.32	$ 1.97	$ 3.91	$ 26.93	$ 3.62	$ 0.78	$ 6.40	$ 9.31	$ 6.71	$ 1.83	$ 7.41	$ 7.50	$ 10.34	$ 10.80	$ 12.75	$ 3.20	$ 8.15	$ 3.72	$ 2.36	$ 396.8

J:\\RioGrande_alts1_mod6_3.xls\Summary Cost

APPENDIX E - RIO GRANDE CANALIZATION PROJECT AREA